SEWER LINE CHEMICAL ROOT CONTROL

With Emphasis on Foaming Methods using Metam Sodium and Dichlobenil

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PREFACE

Sewer line root control is a matter of using the right technologies. To be successful, the technology must be effective and must not adversely affect people or the environment.

The purpose of this training manual is to provide a sound foundation for studying the technical aspects of sewer line root control with emphases on the safe use and application of chemical products, especially those containing metam-sodium, a restricted use pesticide.

On March 1, 1996, metam-sodium for sewer root control was reclassified as a restricted use pesticide. The U.S. Environmental Protection Agency (EPA), which is responsible for registration of pesticide products, made this decision because of concerns that metam-sodium products used in sewers for root control could adversely affect the health of humans, domestic animals and the environment. This action means that metam-sodium root control products may only be purchased by certified pesticide applicators and applied only by or under the supervision of such certified applicators. In addition, Washington State requires that any pesticide, applied commercially or through the use of power equipment, requires a pesticide license. People desiring certification status must apply to the Washington State Department of Agriculture (WSDA).

In order to obtain a license in the Sewer Root Control category, individuals must pass a Laws & Safety exam, the Sewer Root Control exam and pay the applicable fee (based on the type of license). This manual is the study material for the latter exam; the study manual for the Laws & Safety exam is available through Washington State University (WSU). Contact WSU's Bulletin Office at (509) 335-2857 and ask for the manual, *Washington Pesticide Laws and Safety* (MISC0056). Order forms for the manual are also available from WSDA by calling (360) 902-2020.

This manual is a valuable source of information for people preparing for certification.
Each chapter covers material considered essential to the proper understanding and implementation of root control involving chemicals such as metam-sodium. Also included is basic information and guidelines to assist the applicator in solving practical problems involving root control.

This manual was adopted from a federal manual by the Washington State Department of Agriculture. Please communicate any suggestions for revision to: WSDA/Certification & Training/Attention: Margaret Tucker/P.O. Box 42589/Olympia, WA 98504-2589. Thank you!

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CHAPTER 1

PESTS, PESTICIDES AND REGULATIONS

Learning Objectives

After you complete your study of this unit, you should be able to:

- Describe what a pest is and name the different types of pests.
- Explain what a pesticide is.

Pest Management

This chapter is intended to provide the applicator with a general background in the safe use of pesticides. Although this manual focuses on the use of sewer line root control products which contain metam-sodium as an active ingredient, a knowledge of pesticides, what they are and how to handle them safely, is something all collection system applicators should be aware of. For example, a product that is a "degreaser" may, in its marketing material, claim to kill or control roots. Because of that claim, the product is classified as a "pesticide" and is subject to the regulations governing pesticides. All pesticides offered for sale or use in the United States and its territories must be registered with the U.S. Environmental Protection Agency (EPA). In addition, products used in Washington State must be registered with WSDA.

Pests

A pest is anything that:

- competes with humans, domestic animals, or desirable plants for food, feed or water,
- injures humans, animals, desirable plants, structures or possessions,
- spreads disease to humans, domestic animals, wildlife or desirable plants, and
- annoys humans or domestic animals.

Types of pests include:

- insects such as roaches, termites, beetles, mosquitoes, fleas and caterpillars,
- insect-like organisms, such as ticks, spiders and scorpions,
- mollusks, such as snails, slugs, oysters, clams and shipworms,
- weeds, which are any plants growing where they are not wanted, such as mosses, algae, dandelions and any plant part such as root intrusions into wastewater collection systems,
- plant disease pathogens, such as fungi, bacteria and viruses, and
- vertebrates, such as rats, mice, other rodents, birds, reptiles, and fish.

Pesticides

A pesticide is defined as any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant. The wise use of pesticides can contribute significantly to the health, welfare and quality of human life. However, improper use of pesticides can be a threat to human health and environmental quality.

For a more detailed discussion of pesticides and the regulations governing them, refer to WSU's *Washington Pesticide Laws & Safety* manual (MISC0056). This is the study manual for the required Laws & Safety exam.

Test Your Knowledge

Q. When may tree roots be considered a pest?
A. When they become pests when they affect humans' property and well being especially when they invade and damage sewer pipes in search of food and water.

Q. Name several different types of pests.
A. Some insects, other invertebrate organisms such as spiders and ticks, plant diseases, weeds, and vertebrates such as mice and rats.

Q. What is a pesticide?
A. A pesticide is any substance or mixture of substances intended to prevent, destroy, repel or mitigate any pest, or for use as a plant regulator defoliant or desiccant.

CHAPTER 2

ROOTS IN SEWERS

Learning Objectives

After you complete your study of this unit you should be able to:

- ■Determine the two different types of root systems and which is associated with sewer problems.
- ■ Be familiar with factors around sewer pipes that influence root growth.
- ■ Identify the two types of root structures in sewer lines.
- ■ Describe at least three non-chemical methods of root control.
- ■ Name at least four different chemical control methods other than metam-sodium.
- ■ Explain the differences between contact and systemic herbicides and between selective and non-selective herbicides.
- ■ Describe three methods used to identify which sewer lines have root problems.

Root Related Sewer Problems

The intrusion of roots into sewers is probably the most destructive problem encountered in a wastewater collection system.

Root related sewer problems include:

- ■ sewer stoppages and overflows,
- ■ structural damage caused by growing roots,
- ■ formation of septic pools behind root masses which generate hydrogen sulfide, other gases and odors,
- ■ reduction in hydraulic capacity, and loss of self-scouring velocities,
- ■ infiltration where the pipe is seasonally under the water table.

Sewer stoppages and overflows are the way that most municipalities and homeowners find out about their root problems. Structural damage, on the other hand usually goes unnoticed until the damage is determined through television probing. In the long run, structural damage is probably more costly than sewer stoppages.

Sewers are underground, so root problems are not noticed until backups or overflows occur. Effective use of early, preventive root control can avoid costly and permanent structural damage. However, many municipalities are unlikely to fund a preventive root control program until a known problem alerts officials to the need for control.

Root Growth

Roots have three basic functions: 1) they anchor the plant and hold it upright, 2) they store food for the plant, 3) and they absorb and conduct water and nutrients.

Roots are tenacious and long-lived. The top of a plant is more dependent on the root system for survival than vice-versa. A plant can regenerate after it has been topped but cannot survive the loss of its root system. A willow tree root system can survive for many years after the top has been removed and will continually try sending up new shoots through the stump or exposed roots. The root systems of some grasses of the American Great Plains are thought to have remained alive for thousands of years. Just how far roots will grow in search of moisture and nutrients is uncertain. In the Rocky Mountains in Colorado, live tree roots have been found penetrating a pipe in the Moffet tunnel, 2500 feet from the nearest tree.

Root Systems. Plants may have either a fibrous root system or tap root system. Plants with **fibrous root systems**, such as garden plants and grasses, occupy the upper layers of soil and extend outward. They are not normally associated with sewer problems.

Tap root systems. Examples of plants with tap root systems are the trees and woody plants. The primary root of the plant grows directly downward into the soil. Tap root systems are well adapted to deep soils and soils where the water table is relatively low. Branches, or secondary roots, grow laterally from the primary root. Secondary root structures can grow several inches in diameter, and if they invade sewer pipes can exert enough pressure to spread pipe joints and break pipe.

Feeder roots are fine, hairlike roots that may develop into secondary roots. The surface of feeder roots contain microscopic structures called root hairs. Root hairs greatly increase the total surface area available to absorb nutrients and water.

The leading tip of a root shoot, the **meristem,** "senses" minute differences in nutrient and moisture levels and grows toward them. The ability to detect these differences enables the root to locate a sewer pipe. Temperature variances between wastewater flow within a pipe and surrounding soil may cause condensation to form on the pipe. Also, loose pipe joints, cracks, and pipe porosity allow high nutrient content water to seep from the pipe into the surrounding soil. This type of environment attracts and encourages root growth.

Factors Affecting Root Growth. A number of different soil conditions around sewer lines influence root growth. Back fill used during sewer construction may provide more favorable soil than the existing, undisturbed soil. Water table levels will fluctuate with seasonal changes. During drier seasons, the water table drops and tree roots will grow deeper in search of moisture. The tendency of roots to grow towards moisture is called hydrotropism. Sewer lines above the water table will draw roots in that direction. During colder seasons, especially where ground frost occurs, the warmer soil temperatures surrounding the sewer pipe may also cause the roots to grow in that direction. Moisture and warm temperatures surrounding a sewer pipe create an excellent environment for root growth. If the moisture level drops below a certain point, roots will begin to wilt.

Microscopic openings permit hair-like structures to penetrate pipe joints, cracks, connections, or any other opening. Heavy secondary root structures may follow a sewer pipe for many feet, exploiting each opportunity to penetrate pipe joints.

Roots thrive in sewer pipes, a perfect hydroponic environment. Roots are suspended in a well-ventilated, oxygen rich environment with a plentiful supply of water and nutrients.

Generally, root growth is greatest in fall, winter, and spring before leafing. At this time roots are either storing or distributing nutrients. Root growth is less active in the late spring and summer when the above ground portion of the tree is growing. Little is known about the growth rate of tree roots.

Roots of most trees cannot grow or survive if constantly submerged in water. Therefore, roots generally do not cause problems in sewers that are located below a permanent water table. With adequate water, available roots need not expend energy trying to penetrate the water table and sewer pipes. However, if the water table fluctuates, or if porous soil profiles permit rapid downward movement of rain water, roots can be found in saturated soil and can be a major cause of sewer infiltration. In this case, tree roots suspended in the atmosphere of the sewer can carry on metabolic activity while the woody, submerged portion of the root system serves as a pipeline for plant nutrients.

Roots must always grow because parts of the root system are constantly dying. If a root system stopped growing, the plant would die. When the nutrients or moisture in an area of soil is depleted, feeder roots die. Secondary roots elongate or stop growing, depending on the availability of additional nutrients. In time, bacteria in the soil break down the dead root tissue, helping to replenish the depleted nutrients.

Roots in the Sewer Environment.

In urban environments, finding good sources of nutrients for tree roots may be difficult. Expanses of concrete and asphalt, removal of leaves and other organic debris from lawns and storm sewers, and draining away surface water all cause roots to seek nutrition at greater depths. Some roots may follow building sewers well beyond the tree's drip line to the main line sewer.

Two types of root structures found in sewer lines are known as veil and tail. The **veil root structure** occurs in lines with steady flows, such as interceptor pipe and other lines with constant flow. The roots will penetrate pipe at the top or sides and hang from the upper surface, like a curtain, touching the flow. Live roots are seldom found below the water line. The roots will rake the flow accumulating solids and debris. Grease and other organic materials will also accumulate. Eventually the root mass and accumulated material will cause a stoppage of flow and gasses may develop.

The **tail root structure** occurs in sewers that have very low or intermittent flow, such as in small diameter collector sewers, building sewers, and storm drains. The tail root structure looks like a horse's tail. The roots will grow into the pipe from the top, bottom, or sides, and continue to grow downstream filling the pipe. Tail root structures over 20 feet long have been removed from sewers. Such root structures may appear as solid tubes of tree root, possibly with a slightly flattened area along the bottom where submergence in sewer flows prevent root growth.

Roots that enter the sewers or are visible during a television inspection represent only a small percentage of total root structures in the vicinity of the sewer. Roots girdling the pipe on the outside are responsible for pipe damage as they swell inside joints and cracks.

Non-Chemical Methods of Root Control

Chemical, as well as several non-chemical methods of sewer line root control are available to the root control expert and the public works officials. Although non-chemical methods generally do not provide the same level of results as chemical methods, they have an important place in sewer maintenance. For example, mechanical methods are best for opening plugged sewers and for removing roots from sewers that are at imminent risk of plugging. In some cases, chemical control methods should not be used, especially when near treatment plants or due to other environmental or safety considerations. Pipe re-lining, grouting and sealing may also deter intrusion by roots. Municipal planners may discourage future root problems by discriminate selection and planting of trees in the proximity of proposed sewer lines. A successful line root control program will integrate cultural, physical, mechanical, and chemical root control methods.

Cultural Control. Cultural control of roots in sewers include routine management practices that can prevent tree roots from invading sewer lines. Cultural control must be implemented before roots have a chance to become a problem. Two major cultural methods are: 1) careful installation and inspection of sewer lines during construction, and 2) control of the selection of tree species and planting sites. Sewer connections with air-tight joints and seams, will make it difficult for roots to penetrate. Municipalities should carefully inspect connections where plumbers join building laterals to the main-line sewer. Also, homeowners should be advised of the potential for future root problems and should be discouraged from planting deep rooted or fast growing trees near sewer lines. Willow trees, in particular, have adventurous and thirsty roots. Unfortunately, when a sewer root problem is detected, it is too late for cultural control.

Physical Control. Physical pest control relies on devices or procedures which physically separate the pest from the target area. A mosquito net is a physical pest control method. Physical control of sewer line roots involves isolating the environment of the sewer pipe from the roots around or near the sewer pipe. Three examples of physical control are: 1) tree removal, 2) pipe replacement, and 3) pipe re-lining.

Tree removal. This method works best when removing a single troublesome tree such as a willow whose roots have invaded pipes. Unfortunately, it is difficult to convince homeowners along "Shady Lane" that the municipality's public works department should remove their trees in the vicinity of sewer lines. This would not only be expensive but would not guarantee removal of the root problems. Roots may survive long after the death of the above ground part of the tree, necessitating the use of mechanical or chemical controls for some time afterward. For tree removal to be most effective, the stump should be pulled or chemically treated with a basal application herbicide.

Pipe replacement involves removing old, defective sewers and replacing them with new sewers. As discussed above, the new sewers must have air-tight joints and properly installed connections in order to prevent the roots from becoming a problem. Pipe replacement corrects structural defects as well as root problems. There are four major disadvantages to pipe replacement: 1) cost, 2) disruption of traffic and property, 3) roots can still enter through building sewers, and 4) the destruction of trees planted in the vicinity of the trench line. If the pipe is in danger of collapsing, or is in a state of structural failure, pipe replacement may be the best method of control. Pipe replacement is not warranted when the pipe is in sound structural condition.

Pipe lining includes various technologies for rehabilitating sewer pipe. Roots must be chemically or mechanically removed prior to installation. One method, "Slip-lining" involves pulling a seamless pipe through the existing sewer and digging only where building laterals require connecting. Another method, "Cured-In-Place" lining involves inflating and curing a sock or plastic tube that conforms to the shape of the pipe. Robotic devices are then used to cut building connections into the liner.

Advantages of pipe lining are: 1) addresses infiltration problems and some structural defects, 2) is less disruptive than pipe replacement, and 3) promises long-term control against root regrowth through joints. Disadvantages of pipe lining are: 1) it is often more costly than replacement, and 2) roots can still re-enter the main-line sewer through building laterals. Even after relining the main-line sewer, chemical control may be required to prevent roots from penetrating the main-line sewer through service connections.

Mechanical Control. Mechanical control is the most common method of root control and the most important non-chemical method for applicators to understand. Mechanical control involves the use of tools or other devices which cut and remove roots from sewers.

Drill machines, also called coil rodders, are either hand or power-driven, spring-like, flexible steel cables which turn augers or blades within the sewer. They are most often used by plumbers to relieve blockages in house-lines or other small diameter sewers. They are seldom used in main-line sewers.

Rodding machines are flexible steel rods with attached rotating blade cutters, augers, or corkscrews. Rodding machines are most effective in small diameter sewers up to 12".

Jetters are also known as flushers, flush trucks, jet rodders, jet trucks, and hydraulic sewer cleaners. Jetters consist of a high pressure water pump, water tank, hose reel, and 1/2" to 1" sewer cleaning hose. Orifices in the rear of the nozzle propel the hose through the sewer. The nozzle blasts through obstructions. As the hose and nozzle is retrieved, debris is hydraulically flushed back to the insertion manhole for removal. Jetters can also be equipped with root cutters which use the force of water to spin blades. Unfortunately, root cutters can easily get stuck in the sewer, especially where there are protruding taps or other structural defects. Bound cutters can only be removed by digging them out.

Winches, also called drag machines or bucket machines, are large, engine-driven winches which pull buckets, brushes, or porcupine-like scrapers through the sewer. Special tools are designed to cut roots. Winches are most often used on large diameter sewers which cannot be cleaned efficiently with jetters. Winches are used in heavy cleaning to remove large volumes of solids.

The main advantage of mechanical control is that it is the only method of relieving a root blockage. Chemicals are ineffective and dangerous when used in plugged or surcharging sewers. Sewer stoppage is an emergency situation and the municipality should have some type of mechanical control device for correcting such problems.

The main disadvantage of mechanical control is that it provides no residual control or long-term effectiveness. Roots respond to injury by producing a hormone, abscisic acid, which hastens and thickens regrowth. Root masses grow back heavier each time they are cut. Tap roots continue to grow in diameter and, in time, place additional stress on sewer pipes. Good results are obtained if the roots are cut flush with the joints; however, offset joints and cut-in laterals can prevent the use of full-gauge cleaning tools.

Mechanical control is often used in conjunction with chemical control. One example of this is when sewer lines are being prepared for rehabilitation with pipe-lining and grouting.

Chemical Root Control. Pesticides are the fastest way to control pests. Choosing the best chemical for the job is important. Chemicals used to control weeds are called herbicides. They kill plants by contact or systemic action. A **contact herbicide** has a localized effect and kills only the plant parts which the chemical comes in contact with. **Systemic herbicides** are absorbed by roots or foliage and carried throughout the plant. Contact herbicides result in quick die-back. Systemics take longer, two weeks or more, to provide the desired results. Metam-sodium is a contact herbicide.

Herbicide activity is either selective or non selective. **Selective herbicides** kill certain types of weeds such as broadleaf or grassy plants. They are used to reduce unwanted weeds without harming desirable plants. **Non selective herbicides** kill all plants present if applied at an adequate rate. They are used where no plant growth is wanted. Metam-sodium is a non selective herbicide.

Many chemicals have been tried for root control. The more common ones used today are discussed below.

Trifluralin. Brand Names: Treflan, Bio-Barrier.

Fabric or rubber impregnated with trifluralin pellets is a relatively new concept in sewer line root control. The impregnated fabric is placed between the sewer pipe and trees at the time of sewer installation. The porous fabric allows water to pass through. The trifluralin pellets are time-released, with manufacturers' claims that the active ingredient leaches only a few inches before being trapped by soil particles. Impregnated rubber is used for joint gaskets.

Three advantages of this method are: 1) root control is long-lasting without a need for re-treatments, 2) pesticides are not directly introduced into the sewer collection system, and, 3) environmental risk is minimized.

The main disadvantage of this method is that it cannot be employed economically after a problem occurs. In addition, it is an unnecessary economic expense if the pipeline is adequately installed in the first place. Modern pipeline installation, if done correctly, can adequately deter root penetration.

Copper Products. Synonyms: Copper Sulfate, Bluestone. Numerous brand names

Although small amounts of copper are required by plants for normal growth, excessive amounts of copper will cause leaf damage and could result in the death of the tree. Copper is a heavy metal which may not be removed by the normal treatment process. Not only can it be toxic to the treatment plant's microbes but it exits the treatment plant as a pollutant in both the effluent and the biomass (sludge), thus becoming a potential environmental contaminate.

Copper Sulfate has been used for many years for root control in sewers and as an algaecide. Some studies have shown that high concentrations of copper sulfate cause systemic injury without completely killing the roots. Nevertheless, copper sulfate products are still in widespread use by many plumbers and homeowners as a "pour down" application for controlling roots in building sewers. Copper sulfate is believed to be a relatively safe material to handle, posing little health risk to the applicator.

The use of copper products may not be permitted in some states. Check with local authorities before using.

Metam-Sodium and Dichlobenil

Metam-sodium and dichlobenil have been used together as a root control product in sewers for approximately 25 years. Metam-sodium is a fumigant. It breaks down into a gas, methylisothiocyanate (MITC), which kills the plant roots. It is a contact, non-systemic pesticide. Metam-sodium is used in combination with dichlobenil which is an effective growth inhibitor.

These two pesticides were originally applied together by spray or soak methods. Soaking entailed plugging the pipe, filling it with the chemical for a period of time, allowing the chemicals to penetrate any blockages as well as soaking out cracks and joints to kill further up the root system. Spraying involved spraying the interior of the pipe with the chemical solution. Because of the large doses of chemical used and their apparent threat to treatment facilities, the soak and spray methods are no longer recommended.

Current methodology uses metam-sodium products as a dry foam (similar to shaving cream). Specialized foam generating equipment is used to produce the foam which is then applied to the interior of the pipe. Application is made through a hose which is inserted the length of pipe to be treated. While the hose is being retracted, foam is pumped through the end filling the pipe with foam. As the foam collapses (over a period of 1 hour or more) it has a tendency to adhere to the pipe and root surfaces.

Any product that does not adhere to the roots and pipe walls enters the wastewater in the pipe and is carried to the treatment facility. The dilution of the product in the wastewater, and the rapid breakdown (fuming off) of the metam-sodium, allows a safety margin for the treatment plant.

Once the roots have been killed (within hours of application), bacteria and other microbes in the sewer begin to breakdown the dead tissue. Total decomposition of the roots may take several months to a year or more. The decomposed organic matter enters the wastewater stream and is carried to the treatment plant for disposal. Root regrowth will start in a couple of years which may necessitate retreatment at 3 to 5 year intervals.

Identifying Which Lines Have Root Problems

Pest identification is usually the first and most important step in a pesticide control program. In sewer line chemical root control, pest identification is not a issue because it does not matter which species of tree is producing the nuisance roots. All roots in sewers are pests - there are no beneficial species.

In sewer line chemical root control, the sewer applicator is confronted with the problem of determining which sewer lines have been infiltrated by roots. Several indicators are available for determining which collection lines have root penetration:

(1) Maintenance histories. Maintenance records will indicate sewer lines which have experienced a stoppage and the cause of stoppage.

(2) Sewer line television reports. These provide accurate evidence of a root problem.

(3) Commonalties in root prone areas. Generally, sewer lines in the same area, that were installed at the same time with similar tree-planting patterns near sewers, will experience similar root problems.

Conditions which increase the likelihood of root problems in a particular sewer section are:

- Sewers located near other sewers with known root problems.
- Sewer pipes located near the surface and closer to tree roots.
- Sewer-lines located off-road in wooded easements, or at a curb line, near trees and roots.
- Sewer-lines with many lateral connections per lineal foot, affording greater opportunity for root intrusion.
- Sewer-lines located in tree-lined streets and easements.
- Residential areas are more susceptible than industrial areas.
- Sewer pipe constructed with loose fitting joints or out-dated joint packing material. (Asbestos-cement pipe, orangeburg pipe, and clay tile sewers with oakum joints are very susceptible to root penetration whereas pipe with air-tight rubber gaskets and seamless pipe are less susceptible).

A useful tool for planning root control programs is the scattergram. This is a map of the sewer collection system with known root problem lines highlighted. As a root-related stoppage occurs, or if other evidence of a root problem is detected, the line is highlighted on the map. Over time, patterns will emerge for areas that are root prone.

Foam is used to deliver root control chemicals because:

- it effectively fills the pipe void above the flow line, contacting the pipe walls and root masses,
- it does not break down for a period of time after application, maintaining the required contact time for metam-sodium,
- it prevents metam vapor from drifting through the pipe into manholes and house vents,
- it contains surfactants and emulsifiers which assist the herbicides in penetrating through the grease and organic deposits on the root masses, increasing the effectiveness of metam-sodium, and
- it allows treatment while pipes remain in service.

Dry Formulation

Wettable Powders (WP). Wettable powders are dry, finely ground formulations which look like dusts. They must be mixed with water for application. Dichlobenil, as used in sewer line root control, falls into this classification.

Metam-Sodium

Metam-sodium is a fumigant pesticide with end use products formulated as 18% to 42% aqueous solutions. This chemical has been registered since 1954 for use as a preplant fumigant to control weeds, nematodes, fungi, bacteria and insects. There are approximately 35 registered metam-sodium products. Additional uses include wood preservation, slimicide, tree root control and aquatic weed control. Metam-sodium has been used commercially in combination with dichlobenil for sewer root control since the early 1970's.

Reactivity. Metam-sodium is stable under normal conditions and very stable at a pH higher than 8.8. The commercial metam-sodium formulation is stable at a buffered pH of about 10. Metam-sodium is unstable at a pH below 7 at which point it hydrolyzes (breaks down into other products). Prolonged exposure to air results in gradual decomposition to form MITC, a poisonous gas. When metam-sodium is mixed with water it rapidly hydrolyzes to MITC. The MITC gas penetrates the root mass to kill the roots. MITC is much more toxic than its precursor metam-sodium. MITC may reach unsafe levels in poorly ventilated or confined spaces. Use of air-supplied respirators would be required under such conditions.

During normal conditions of use, metam-sodium is diluted with water with air added to form a foam. Dilution with water decreases the solution's pH causing rapid hydrolysis of the metam-sodium. In addition to MITC, hydrolysis also yields carbon disulfide (CS_2), hydrogen sulfide (H_2S) and minor products, elemental sulfur and 1,3-dimethylthiourea. In confined space these byproducts could exacerbate hydrogen sulfide problems in collection systems or compromise pre-treatment local discharge limitations.

Inhalation Exposure. Exposure to Metam-sodium by inhalation is assumed to be slight. However, since metam-sodium decomposes to MITC, CS_2, H_2S and other products, extreme caution is important. MITC is a gas that is extremely irritating to respiratory mucous membranes, to the eyes, and to the lungs. Inhalation of MITC may cause pulmonary edema (severe respiratory distress, coughing of bloody, frothy sputum). For this reason metam-sodium must be used outdoors only, and precautions must be taken to avoid inhalation of evolved gas by wearing an approved canister respirator or air supplied respirator. If pulmonary irritation or edema occur as a result of inhaling MITC, transport the victim promptly to a medical facility.

Dermal Exposure. Exposure to metam-sodium through the skin is expected to be minimal if adequate personal protection equipment (PPE) is worn, namely chemical resistant gloves, long sleeved shirt and goggles. Since the surface of the skin is acidic, pH 4.5 - 6, metam-sodium will decompose upon contact with the skin. MITC is extremely irritating to the skin and eyes. Contamination of the skin should be treated immediately with copious amounts of water to avoid burns and corneal injury. If skin or eye irritation persists, seek medical attention.

Developmental Effects. Studies with laboratory animals indicate that metam-sodium ingested over a period of several days can cause pregnant females to lose weight and fetuses and offspring to exhibit skeletal irregularities.

Dichlobenil

Dichlobenil is a residual-type pesticide formulated as a wettable powder, soluble concentrate/liquid, and granules. The chemical has been registered since 1964 as a soil sterilant to control broadleaf weeds, grasses and aquatic weeds. Dichlobenil is also applied as a foam, spray or additive to chemical grouts for the control of tree roots in sewer-lines. For sewer use, it is formulated as a 50% or 85% wettable powder and is frequently used in combination with metam-sodium.

Dichlobenil kills weeds by impairing metabolic processes that are unique to plant life. For this reason it's mammalian toxicity is low. Nonetheless care should be exercised when handling this and any pesticide especially when used in combination with other pesticides such a metam-sodium. Consult the product's label and material safety data sheet (MSDS) for precautionary instructions.

Test Your Knowledge

Q. What is a pesticide formulation?
A. A formulation is a mixture if active ingredients (control material) and inert ingredients (carriers and other agents such as foam).
Q. Describe the formulations used with metam-sodium root control products.
A. Metam-sodium is a liquid formulation that includes a foaming agent or require a foaming agent to be added prior to dispersal. Dichlobenil is a wettable powder that may be added to the metam-sodium foam mixture.
Q. Describe what happens to metam-sodium in the presence of water.
A. Metam-sodium mixed with water will hydrolyze to form MITC, H_2S, CS_2 and other minor products.
Q. How can hydrolysis of metam-sodium affect an applicator.
A. MITC, a product of hydrolysis, is a highly toxic gas.
Q. Why is dichlobenil added to metam-sodium as a root control pesticide?
A. Metam-sodium is a contact herbicide, killing only those root parts it contacts. Dichlobenil is a residual type herbicide that continues to control root growth for a period after application.

CHAPTER 4

APPLICATION CONCERNS-
WASTEWATER TREATMENT PLANTS
LATERAL LINES & BUILDINGS

Learning Objectives

After you complete your study of this unit you should be able to:

- Know the three major components for handling waste water.
- Know the difference between a sanitary and storm sewer.
- Be aware of the variables in a wastewater collection system that influence root control operations.
- Describe the series of treatment processes that remove wastes from the water.
- Understand the purpose of waste water treatment ponds (lagoons).
- Explain the difference between design flow and actual flow.
- Understand how metam-sodium can affect a treatment plant and the processes involved.
- Understand the treatment principles in service lines.

Wastewater Treatment Facilities

Raw wastewater and efficiencies of treatment processes vary from plant to plant. This chapter will provide you with an understanding of the basic operation of a treatment plant and will help you determine the potential risks associated with the application of root control chemicals with emphasis on metam-sodium. It is important that you not only understand the operation of sewer collection systems but you must also have a basic understanding of the treatment process.

Facilities for handling wastewater usually have three major components: collection, treatment, and disposal. An understanding of the treatment process is very important for the applicator, especially when introducing foreign materials, such as root control chemicals or grease eating bacteria, into the collection system. For example, the root control chemical metam-sodium is a general biocide so its potential for affecting the treatment process is directly related to the concentration reaching the treatment plant and the efficiency of that plant's treatment process.

Collection Systems

Collection and transport of wastewater from the source to the treatment plant is accomplished through a complex network of pipes and pumps of many sizes. Typically, the sewer coming into the treatment plant carries municipal wastes from households and commercial establishments and possibly some industrial wastes. This is called a **sanitary sewer.** All storm runoff is collected separately in a **storm sewer** which normally discharges to a water course without treatment. In some areas, only one network of sewers has been laid out beneath the municipality to pick up both sanitary wastes and storm water in a **combined sewer.**

The collection system consists of a series of interconnecting pipes of varying sizes (from 4" pipe to tunnels in which maintenance personnel can float in boats). The majority of the pipe footage in areas serving buildings is 8" - 12" in diameter. The system is designed to provide gravity flow from the point of collection to the treatment plant. Sanitary sewers are normally placed at a slope sufficient to produce a water velocity (speed) of approximately two feet per second, or more, when flowing full. Usually this velocity will prevent the deposition of solids that may clog the pipe or cause odors. The gravity system is broken up into sections by manholes which allow maintenance personnel access to the collection system. Design criteria usually place manholes at pipe junctions, or changes of pipe grade or direction. Therefore, manholes can be spaced between 150 to 1,000 feet, or an average of 250 feet.

Most treatment plants with flows of less than 0.5 million gallons per day (MGD) have pipe sizes 4" - 8" and occasionally 10" - 12". As the plant capacities increase, the pipe sizes increase as lateral flows are collected and approach the treatment plant.

Variables in the Wastewater Collection System that Influence Root Control Applications

Pipe slope is a major design criteria of the collection system. The slope of a sewer is the change in elevation between two manholes divided by the distance between the manholes. Pipe slope and flow velocity can affect the application and detention time of metam-sodium with respect to impacting treatment plants. The design standard for slope is a minimum flow velocity of 2.0' per second with the preferred velocity of 2.5' per second. As the pipes are designed for more slope, the velocity increases. The presence of roots causes the velocities to decrease.

Grade is an important consideration when applying root control chemicals in terms of the effect treatment may have on buildings "below grade". The term grade, although used at times in place of slope, is also used to indicate relative elevation: e.g., a building sewer is termed "below grade" if the elevation of floor drains are below the invert elevation of the upstream manhole. Slope and pipe size and head pressure determine the velocity of the wastewater.

Flow characteristics can affect root growth patterns. Flow may dictate the appropriate treatment method, the rate of root decay after treatment, the rate at which chemicals drift toward the treatment plant, and the rate of dilution of chemicals in the wastewater stream. Flows can be influenced by groundwater infiltration and during peak periods of residential or industrial use.

The greater the velocity of sewer flows the greater the rate at which root control chemicals drift downstream. Foam should be injected above the flow surface to reduce the amount of chemical carried downstream. Pipes with particularly heavy or swift flows should be treated at night or during periods of low flow to improve the efficacy of treatment.

The root control applicator should be aware that heavy or swift flows are more problematic with respect to protecting the treatment plant, and should vary the application rates accordingly. The applicator should also be mindful of force mains upstream from the treatment area. Force mains above treated sections which "kick in" after treatment can wash chemicals out of treated lines and move chemicals downstream towards the treatment plant.

Characteristics of the collection system can affect the efficiency of a wastewater treatment plant and allow the root control chemical to have an unusual influence on the plant. Large water users, such as industries which contribute waste to the collection system, may affect the efficiency of the treatment plant, especially if there are periods during the day or during the year when their waste flows are a major load on the plant. For example, canneries are highly seasonal, making it possible to predict large flows from them. Even in areas where the sanitary and storm sewers are separate, **infiltration** of groundwater or storm water into sanitary sewers through breaks or open joints can cause high flow problems at the treatment plant.

The time required for wastes to reach a plant can also affect a treatment plants efficiency. Hydrogen sulfide gas (rotten egg gas) may be released by anaerobic bacteria feeding on the wastes if the flow time is quite long and the weather is hot; this can cause odor problems, damage concrete in the plant, and make the wastes more difficult to treat (Solids won't settle easily). Wastes from isolated subdivisions located far away from the main collection network often have such "aging" problems.

Pump stations are normally installed in sewer systems in low areas or where pipe is deep under the ground surface. These pump stations lift the wastewater to a higher point from which it may again flow by gravity or the wastewater may be pumped under pressure directly to the treatment plant. A large pump station located just ahead of the treatment plant can create problems by periodically sending large volumes of flow to the plant one minute and virtually nothing the next minute. These fluctuating flows can be reduced by using variable speed pumps or short pumping cycles.

Dilution

The size of a wastewater treatment plant determines the amount of dilution of root control chemicals that occurs with wastewater. Concentrations of pesticides are measured in terms of percent of active ingredient (A.I.) per unit of measure. One gallon of 100% A.I. mixed with 999,999 gallons of water represents one part per million (1 + 999,999 = 1,000,000). The following is an example of determining the amount of active ingredient need in a particular system.

Estimate the maximum concentration of the active ingredient of a product, in parts per million, in wastewater as it enters the wastewater treatment plant headwords.

Label instructions say to mix 10 gallons of Product (25% A.I.) with 200 gallons of water. This solution is converted into foam at a ratio of 20:1, foam to solution. This material is applied over the course of two hours to a sewer system with flows of 380,000 gallons per hour.

Note: The 200 gallons of water used in the mix and the foam expansion ratio is irrelevant to the answer.

(1) If 10 gallons of product is applied over two hours, then 5 gallons of 25% A.I. product is applied in one hour. Therefore:

(2) $\frac{5 \text{ X } 0.25}{380,000} = \frac{\text{Parts Product (x)}}{1,000,000}$

(3) $1.25 \text{ X } 1,000,000 \div 380,000(x)$
$(1,250,000 \div 380,000(x))$

(4) $(x) = 3.289$ or the yield is:

(5) 3.29 parts of A.I. per million gallons (ppm) of water.

Laboratory tests indicate that the "no observable effect limit" (NOEL) for foaming root control products containing metam-sodium and dichlobenil is a concentration of 10 ppm A.I. metam. Seven (7) ppm A.I. metam is used in order to provide a minimal safety margin. By using what we have learned about sewer line flows, we can estimate the amount of active ingredient, or product, necessary to achieve a given concentration.

Example: An applicator learns from the treatment plant operator that average day-time flows are 5 million gallons, and that this is spread evenly over the 8 hour day in which the applicator intends to work. What amount of product can the applicator apply over the 8 hour day to stay under 7 parts per million?

Answer: 5 MG x 7 PPM ÷ .25 (%) A.I.
(3,500,000) ÷ .25 = 140 gallons of product
140 gallons ÷ 8 Hrs. = 17.5 gallons per hour of 25% A.I. Product

Note: No two treatment plants are alike. Two plants with the same flow may react very differently to the same concentration of pesticide in wastewater flow. The biological process of one plant may be under more stress, such as lack of oxygen, chemical pollutants, excessive organic loading, operator error, etc., than a second plant. A treatment plant operating under one or more of these stresses may react to a very small concentration of a pesticide such as metam-sodium and become "upset" (adverse change in the biological decomposition process that can last from hours to days). The same plant, operating well and unstressed, may be able to tolerate several ppm of metam-sodium without effect. Treatment plants become upset for a number of reasons, only one of which may be traced to root control chemicals. A well run plant is usually more tolerant and resilient to pesticides.

The best source of information about a given plant and how it is responding to root control treatments is the wastewater treatment plant operator. All root control activities need to be cleared and coordinated not only with treatment plant operators but line maintenance and pretreatment personnel as well.

Disposing of Excess Chemicals - Effect on the Plant

Dichlobenil and metam-sodium have certain physical properties which lend them to either absorption or degradation in the pipe section being treated. The foaming method of application retains the metam in the pipe section being treated for a period of time. This allows decomposition of the product to take place, thus reducing the risk to the receiving treatment plant. Excess concentrate or mixed solution should not be "dumped" into the sewer lines as it may not have time to degrade enroute to the plant. The material may hit the plant as a "slug" and temporarily upset the plant. If the applicator has any unwanted concentrate or solution the safest way to dispose of it is by applying it according to label instructions. Never dump concentrated product or chemical/water solution into the sewer system.

NOTE: To determine the daily recommended dosage of metam-sodium root control chemicals to a particular system see calculation procedures in Chapter 5 - Application of Metam-Sodium Root Control Chemicals.

Treatment Plants

When wastewater reaches a wastewater treatment plant, it flows through a series of treatment processes (Figure 2) which remove the wastes from the water. This reduces a potential public health threat before it is discharged from the plant. The number of treatment processes and the degree of treatment usually depend on the uses of the receiving waters.

The following provides an introduction to the names of the treatment processes, the kinds of wastes the processes treat or remove, and the location of the processes in the flow path. Although not all treatment plants are alike, there are certain typical flow patterns that are similar from one plant to another. Figures 3, 4 and 5 show possible flow patterns through treatment plants - pond treatment plant, trickling filter plant, and activated sludge. The differences in treatment process, daily flows and treatment plant operating efficiency all affect the treatment plant's ability to tolerate pesticides such as metam-sodium.

When wastewater enters a treatment plant, it usually flows through a series of **pretreatment or preliminary treatment processes** - screening, shredding, and grit removal. These processes remove the coarse material from the wastewater. Flow-measuring devices are usually installed after pretreatment processes to record the flow rates and volumes of wastewater treated by the plant. Pre-aeration is used to "freshen" the wastewater and to help remove oils and greases.

Next the wastewater generally will receive **primary treatment**. During primary treatment, some of the solid matter carried by the wastewater will settle out or float to the surface where it can be separated from the wastewater being treated.

Secondary treatment processes usually follow primary treatment and commonly consist of biological processes. This means that organisms living in the controlled environment of the process are used to partially stabilize (oxidize) organic matter not removed by previous treatment and to convert it into a form which is easier to remove from the wastewater. The current design parameters for secondary treatment plants is to provide 3 - 30 hours detention time in the aeration portion of the treatment process. Retention time design is a function of plant size and plant type. For example, a small extended aeration plant would probably require a 24 hour detention time while a 5 - 10 MGD plant would require 6 - 8 hours of detention time.

TREATMENT PROCESS	FUNCTION
PRETREATMENT	
INFLUENT	
SCREENING	REMOVES ROOTS, RAGS, CANS & LARGE DEBRIS (HAUL TO LANDFILL)
GRIT REMOVAL	REMOVES SAND & GRAVEL (HAUL TO LANDFILL)
PRE-AERATION	FRESHENS WASTE WATER & HELPS REMOVE OIL
FLOW METER	MEASURES & RECORDS FLOW
PRIMARY TREATMENT	
SEDIMENTATION AND FLOTATION	REMOVES SETTLED & FLOATING MATERIALS
SOLIDS HANDLING	TREATS SOLIDS REMOVED BY OTHER PROCESSES
SECONDARY TREATMENT	
BIOLOGICAL CHEMICAL PHYSICAL PROCESSES	REMOVES SUSPENDED & DISSOLVED SOLIDS
DISINFECTION	KILLS PATHOGENIC ORGANISMS
EFFLUENT	

Figure 2

Possible flow pattern through a
Pond Treatment Plant

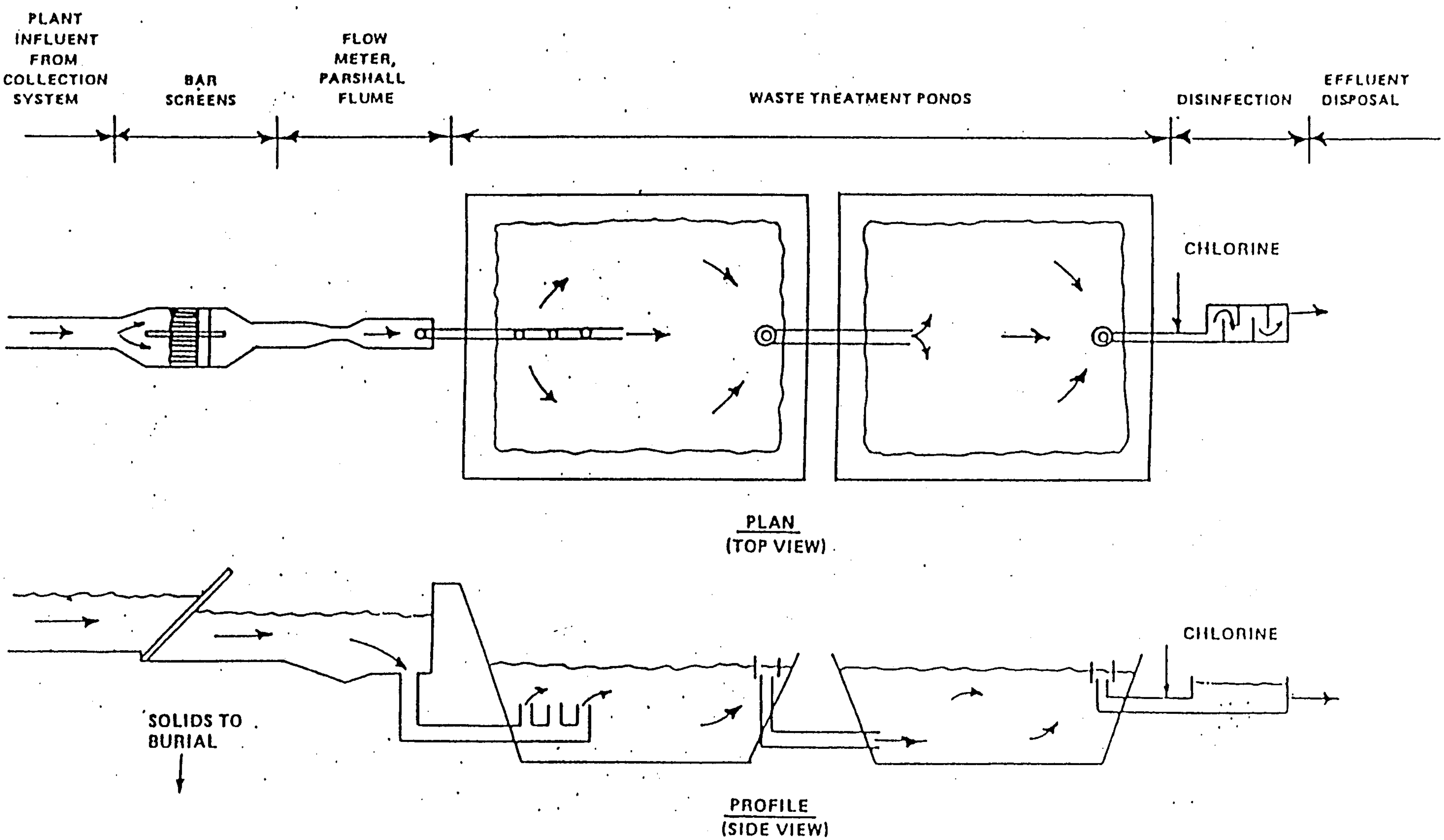


Figure 3

(Con'd) Possible flow pattern through a Trickling Filter Plant

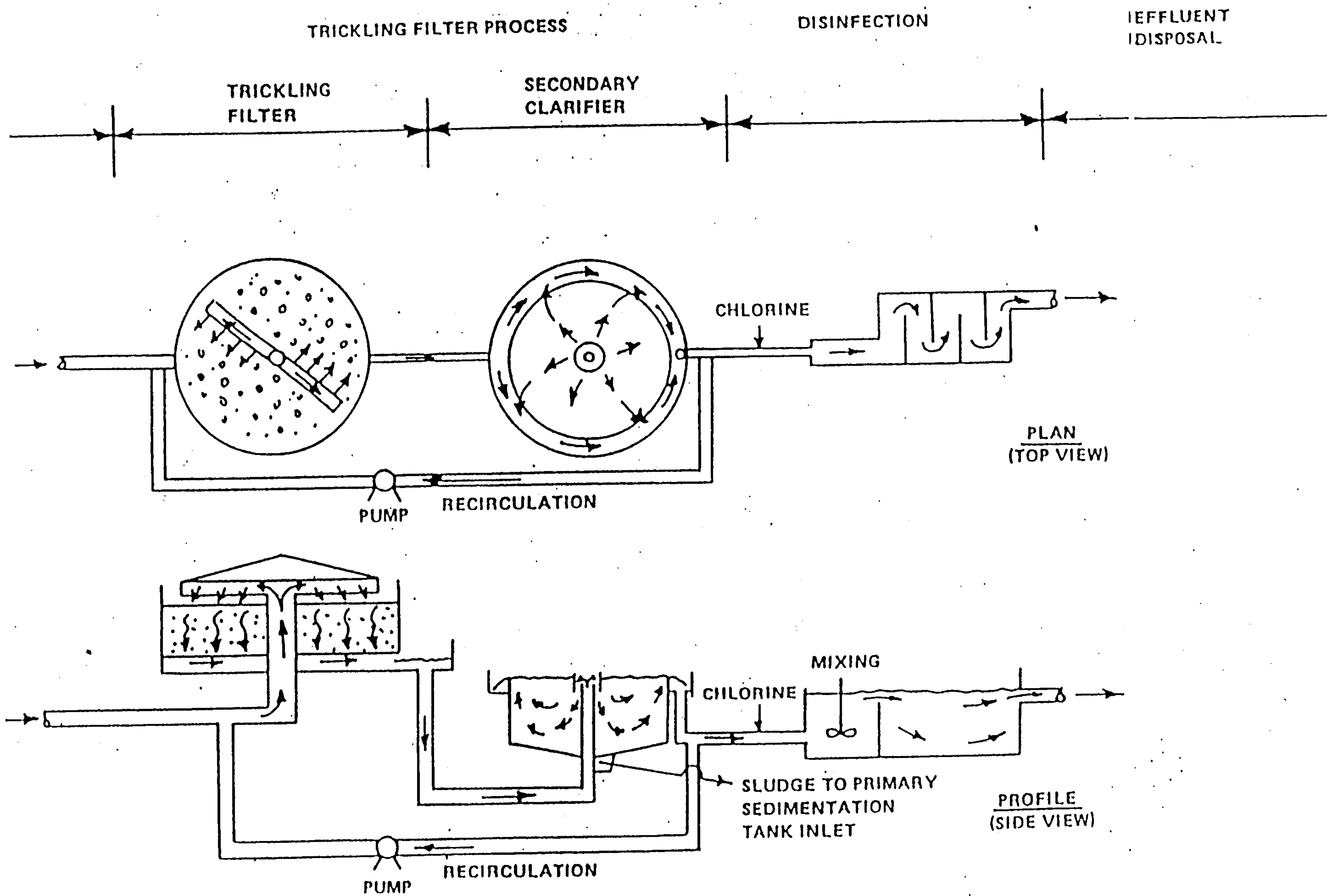


Figure 4

(Con'd) Possible flow pattern through a Trickling Filter Plant

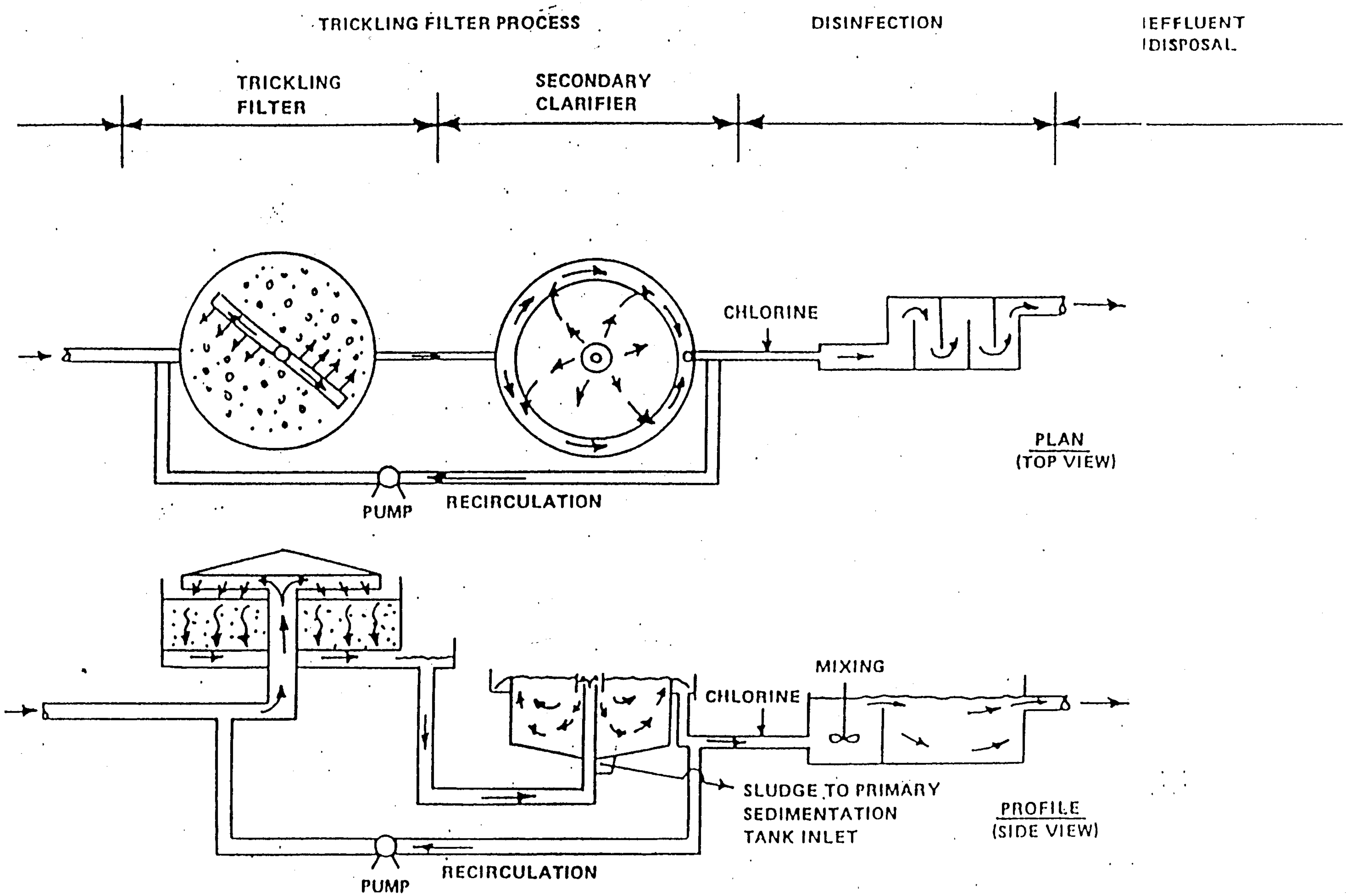


Figure 4 continued

Possible flow pattern through an
Activiated Sludge Plant

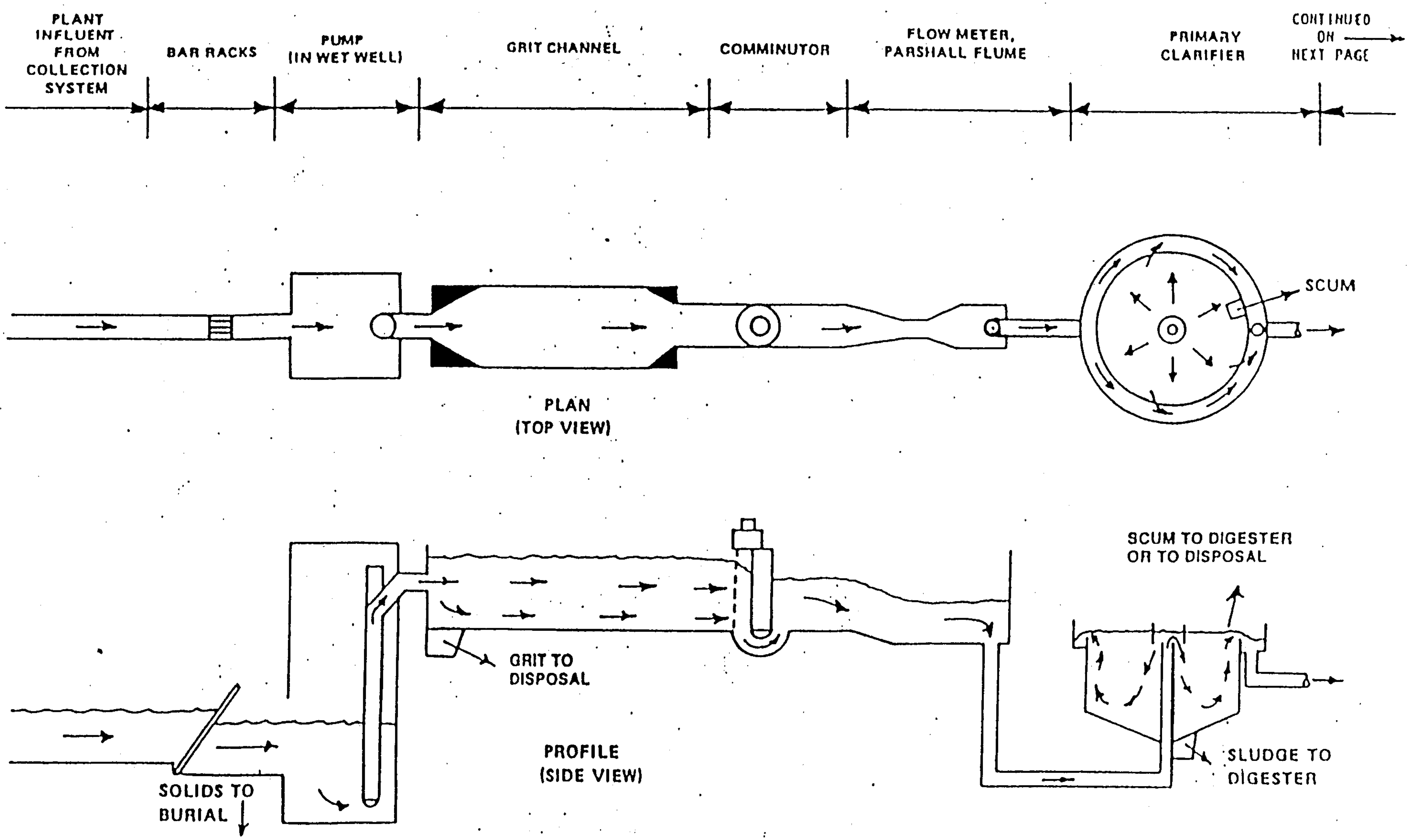


Figure 5

(Con'd) Possible flow pattern through an
Activated Sludge Plant

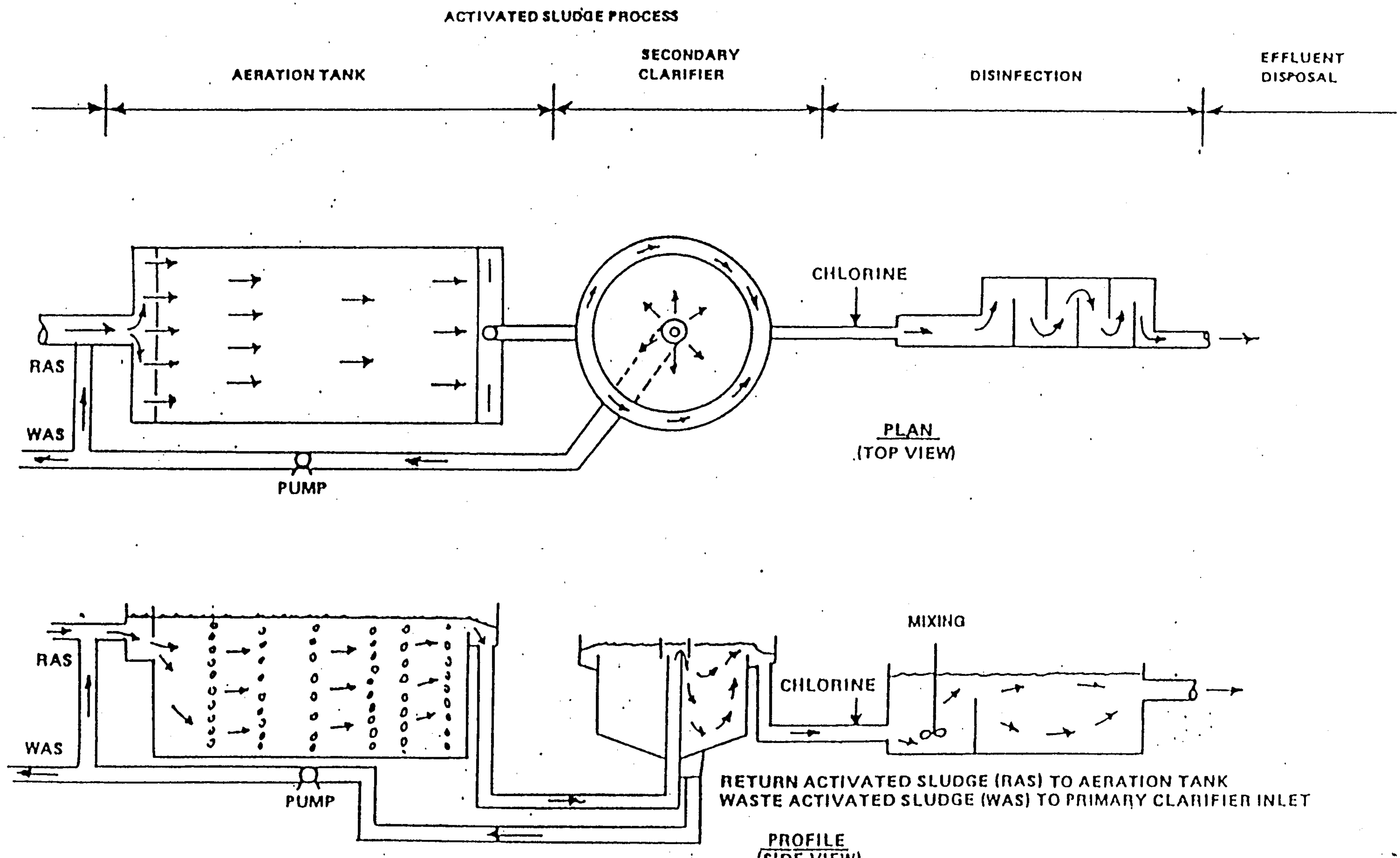


Figure 5 continued

Waste material removed by the treatment processes goes to a solids handling facility and then to ultimate disposal.

Waste treatment ponds, called lagoons, may be used to treat wastes remaining in wastewater after pretreatment, primary treatment, or secondary treatment. Lagoons are frequently constructed in rural areas where sufficient land is available. Flow-through time for lagoons is 4 to 60 days depending on the design.

Advanced methods of waste treatment have been developed for general cleanup of wastewater or removal of substances not removed by conventional treatment processes. These methods may follow the treatment processes previously described, or they may replace them.

Before treated wastewater is discharged to the receiving waters, it should be disinfected to prevent the spread of disease. Chlorine is usually added for disinfecting purposes. Sulfur dioxide (SO_2) may then be added to the **effluent** to neutralize the chlorine.

The Size of the Wastewater Treatment Plant. The physical size of the wastewater treatment plant is often the most important factor in determining the effects of chemical root control treatments. It is very important for chemical root control applicators to know the size of the wastewater treatment plant downstream from their applications.

The size of a wastewater treatment plant is measured in terms of the amount of wastewater it is capable of treating. When discussing flows into wastewater treatment plants, it is important to distinguish between <u>design</u> flows and <u>actual</u> flows. Design flow is the amount of wastewater that the treatment plant is designed to handle on a daily basis.. Actual flows are just that - the actual volume of water that enters the treatment plant on a given day. If the capacity of a wastewater treatment plant is exceeded, excess flows are by-passed around the treatment plant and dumped directly into the receiving waters. Some treatment plants have large basins to temporarily store untreated flows.

Generally, most flows in a sanitary sewer system occur during the daytime hours. A general estimate is that one-half or more of the daily flow of a wastewater treatment plant occurs between 6:30 - 8:30 a.m. and 4:00 - 9:00 p.m.. This estimate could vary depending on local industries and inflow/infiltration rates.

A typical residence, with 3.5 persons, uses 80 - 85 gallons of water per person per day. This figure does not include industrial use. Using this figure, we could estimate the daily flow for a community of 20,000 people to be approximately 1,600,000 gallons of water per day, excluding industrial discharges. Daily flows are referred to as "million gallons per day" (MGD) so this treatment plant would be a 1.6 MGD plant. If industrial flows are added to that of a residential community then a combined water flow of 100 gallons per person would result. Also, if there is excessive groundwater infiltration this would impact the daily flow rate.

The wastewater treatment plant operator can provide information about the amount of flow entering a wastewater treatment plant at any given time. This information is especially important when dealing with low volume plants.

In order to determine the probable impact of a metam-sodium application on a specific treatment plant, one must consider: the type of application; length of pipe; size of pipe; slope of pipe; distance from the treatment plant; slope to treatment plant; type of treatment; size of treatment plant; method of operation; and existing biological stability. Finally, one must consider the rate of breakdown of metam-sodium in an aqueous solution and more specifically, the breakdown in high organic environments, such as sewers.

Variables in the Wastewater Treatment Facility that Influence Root Control Applications

A large number of variables exist when assessing the probability of an adverse impact on a wastewater treatment plant due to the use of metam-sodium for sewer root control. The following summary of events in the sewer system provides reference calculations to assist metam-sodium applicators.

Root Control Chemicals Containing Metam-Sodium

The phrase, ". . . wipeout or blowout treatment plant" suggests a vision of a wall of rushing water destroying the treatment plant. A more appropriate term is a "biological upset". Upsets can be caused by: changes in loading (biodegradable solids); hydraulics; pH; toxic chemicals (metam-sodium, gasoline, paints, solvents, etc.); operator errors; and mechanical breakdowns. The intensity and duration of these upsets last for a few hours to several days. All treatment plants experience biological upsets from time to time, while some may have several upsets a year. Smaller treatment plants are more susceptible to upsets because one event probably represents a larger percent of the plants flow than would be experienced by a larger plant.

When treatment plants are upset following treatment with products containing metam-sodium and dichlobenil, metam is usually the culprit. Dichlobenil has a relatively low toxicity, and little or no effect on microorganisms at the wastewater treatment plant. Metam-sodium itself will not cause a treatment plant problem, but its breakdown products, MITC, CS_2, and H_2S, can. Previously you saw that Metam-sodium in the presence of water decomposed to form and other products. These products begin to evolve in the sewer line before reaching the plant. Foaming methods of application enhance degradation of metam by: 1) reducing the pH, 2) injecting large quantities of air, and 3) diluting the material with water, and 4) slow breakdown of foam which extends the release of metam into the sewer flow, increasing time and dilution.

The time required for the wastewater containing metam-sodium to travel from the point of application to the treatment plant, combined with its dilution in wastewater, are the key factors affecting treatment plant upset.

Treatment plant features that may be affected by metam-sodium decomposition products are: bacteria population, species diversity, age of population, dissolved oxygen, amount of flow, sludge inventory. Flow conditions and proximity to the plant are important considerations in determining the safe application of metam-sodium.

Effects of Chemical Root Control on Wastewater Treatment Plant Processes

The sewer line root control applicator is responsible for ensuring that an application does not adversely affect the performance of the wastewater treatment plant. Root control applications should not be made where there is likelihood of adverse effects on a treatment plant.

Wastewater treatment plants are biological systems and depend on the growth and reproduction of microorganisms. Root control chemicals are effective because they are toxic to tree roots. These same chemicals can be toxic to the microorganisms at the wastewater treatment plant. In fact, most substances are toxic in large enough quantities, but pesticides are active at parts per million levels.

Plant upset violations must be avoided. Treatment plant operators do not consider risking upset as an option. Municipal treatment facilities are faced with $25,000 per day penalties for National Pollutant Discharge Elimination System (NPDES) permit violations resulting from "upset conditions"

NOTE: Always consult the wastewater treatment plant operator before applying any chemical to a wastewater collection system. All consultations need to be careful and complete. Notice of treatment should be made to pretreatment and line maintenance personnel. The wastewater treatment plant operator can monitor the performance of the plant, and alert the applicator to any adverse effects before the plant goes into upset or violates its NPDES permit.

Several factors influence the way in which pesticides impact a sewage treatment plant. The most important are:

1. type of pesticide and physical properties of the pesticide,
2. flow conditions in the pipe being treated and application method,
3. size of the wastewater treatment plant and dilution factors,
4. size of the lines being treated and distance from the plant,
5. total rate at which pesticides are applied to the system, and
6. individual characteristics of the plant and the extent to which the microbe population at the plant is acclimated to synthetic organics.

Foam Application of Root Killing Chemicals To Building Service Laterals

Extreme caution should be taken when treating building service lines. As the name implies these pipes are connected directly to buildings and the chance of accidentally forcing foam type root killers through the pipe and into the building is always present.

Building service lines connect the building to the sewer main which is usually in the street in front of the building or in an alley (back lot line easement) behind the building. The service lines are usually 4" to 6" in diameter and have been installed at various times and by different people. Records of where these lines go, which buildings are connected to a specific line, and conditions of the pipe are usually non-existent.

Building service lines are normally treated in one of two ways:

(1) when treating the main line with a sufficient amount of foam to fill the main pipe as well as force foam into service laterals, and
(2) installing a foam through plug at the building end of the service line and forcing foam through the service lateral to the main line.

Factors to Consider When Treating Service Lines with Foam

- Foam will follow the path of least resistance.
- Service laterals are normally small diameter pipe (4") and a small amount of foam will go a long way: For example:
  8" pipe = 2.6 gallons of foam treatment per foot
  4" pipe = 0.65 gallons per foot (a four fold difference)
- It is much easier for a root mass to entirely block a 4" pipe than an 8" pipe. Calculations of the volume of foam to treat a specific pipe are based on clean empty pipe. Root masses reduce that volume. Root masses affect the volume of a 4" pipe much more than a larger pipe such as 8".
- What may look like a simple service lateral from a building to a main line may have other building laterals connected to it. As sewer technicians know, building areas often began as smaller groupings of homes and commercial buildings built by different developers or individuals. After several growth years, these have grown together into one developed community. The applicator can not be assured that all of these smaller building areas have underground utilities that fit today's designs and materials. There may be some surprise connections.
- The applicator should not rely on any one's (even his own) memory as to how a service lateral was constructed. If possible, the line should be televised prior to treatment to determine any areas that could cause concern in the foaming operation.
- The condition of a particular service line is almost always "unknown". The applicator should proceed with caution and not treat if there is any doubt.

Sewer Main to Building

When treating the main line, a common practice is to increase the amount of foam applied in order to force the excess into service lines thus providing root control. Essentially the applicator reduces the rate of hose retraction during the foam application process, since foam taking the path of least resistance will travel through the service lines. On the surface, this practice appears to be an excellent idea, however, this practice involves significant risk of accidentally forcing chemical foam into buildings.

Do not ever attempt to treat more than the lower 10' - 20' of service lateral by this method. Normal treatment of the main pipe is sufficient to kill roots at the service connection. The higher the percentage of service lateral length you attempt to treat by this method, the greater the risk of accidental contamination in a building.

Risk factors in buildings are:

- basements with below grade plumbing,
- floor drains,
- dry traps,
- reduced sewer pipe volumes due to flow, low spots or root masses, and
- unknown connections to the service lateral being treated.

Building to Sewer Main (Pump through plug)
This method of application is less risky than attempting to treat service laterals from the main line. However, it is not without risk. In principal, a plug is inserted in the service lateral between the point of treatment and the building thus blocking the foam from entering the building.

The most common procedure is to use a specially designed air plug that be inserted through a clean out. The plug is simply a 1" hose with an air bladder molded around the outside. The hose is inserted through a clean out into the down stream sewer pipe. The bladder is than inflated. Foam is pumped through the hose and is forced down the service lateral to the main. The inflated bladder blocks the foam from exiting the clean out or being forced back toward the building. Although not recommended, this process can be used from a clean out on the interior of the building.

Risk factors may be:

- unknown connections to the service lateral being treated,
- inserting hose into upstream pipe instead of down stream,
- handling chemical on private property - accidental spills on landscaping or in buildings,
- when treating from within buildings the location and configuration of the building plumbing may not have pipe branch connections between the hose plug (treatment location) and the main line.

Treating service laterals is high risk. If there is any question as to the exact configuration of service laterals **do not** treat. Do not treat service laterals from buildings to which you do not have access at the time of treatment. Have a spotter in all buildings when service laterals are being treated.

Test Your Knowledge

Q. What are the three components of handling wastewater?
A. The three components are collection, treatment and disposal.

Q. What is the difference between a sanitary sewer and storm sewer?
A. A sanitary sewer collects waste form buildings and transports it to a treatment plant before emptying into a watercourse. A storm sewer collects surface runoff water and transports it directly to a watercourse.

Q. Name several variables in a wastewater collection system that will influence root control operations.
A. Root control operations may be affected by the pipe slope/grade, the flow, characteristics of the collection system, aging of the wastewater and generation of gasses.

Q. Describe the series of treatment processes removing waste from water.
A. Pretreatment/preliminary treatment processes remove coarse material from the wastewater. Primary process involves settling out or floating solid matter for removal. Secondary treatment consists of biological processes converting missed solids into more easily removed material.

Q. What is the purpose of waste treatment ponds (lagoons)?
A. To treat wastes remaining after the other processes. Flow through time is 4-60 days, depending upon design.

Q. What is the difference between design flow and actual flow.
A. Design flow is the amount of flow a system is designed to handle daily. The actual flow is the amount of flow actually passed through a system daily.

Q. How can metam-sodium seriously affect the operation of a treatment plant.
A. If a treatment plant is under stress, the addition of even a small amount of metam-sodium could upset the biological processes and last from hours to days.

Q. What is the applicator's main concern when treating building service lateral line?
A. Forcing foam root control pesticide through lateral lines into buildings.

CHAPTER 5
APPLICATION OF METAM-SODIUM ROOT CONTROL PRODUCTS

Learning Objectives

After you complete your study of this unit you should be able to:

- have a general understanding of foam application equipment,
- explain the basic foaming techniques,
- understand the precautions to follow when filling chemical mix tanks,
- understand the basic concepts of calculating the amount of chemical required for treatment,
- understand the importance of communicating with treatment plant personnel,
- calibrate hose retrieval rate, and
- determine the effectiveness of a root control treatment.

Using the proper application methods and correctly calibrating equipment will assure the most effective use of a chemical. This will minimize the chemical and operational costs of the root control application and protect the health and safety of the applicator, the environment, the public, and the sewer collection system.

When assessing the various methods of application the applicator must understand the principals of applying chemicals as well as the conditions that exist in the pipe being treated.

General concepts about pipe conditions:

- Under normal conditions sewer pipes are not filled with water.
- Pipe sections with sags or depressions may contain more water than other sections. These sections may even be completely filled with water.
- Solids may build up and fill a portion of the pipe.

General concepts about roots in sewers:

- Roots enter sanitary sewers through crack joints and other pipe imperfections from the **top** and **sides** and not from below the flow line.
- Roots do not grow into the liquid flow of the pipe. They only sweep the surface.
- Root growth is most common in the moist atmosphere of the void above the sewer flow line.
- With but few exceptions, roots cannot grow without oxygen.

General concepts about root control chemicals in sewers:

- Root masses are excellent collectors of grease and other solids. Such buildups can inhibit the effectiveness of root control chemicals because they cannot contact the root.

- Chemicals placed in the void area of the pipe with no surface to attach to, such as a root mass or pipe wall, enter the sewer flow and are transported to the treatment plant.
- Chemical root treatments kill roots but they do not eliminate blockages. When a root mass is treated, the roots may die quickly but may take weeks, months, or even years to decay and leave the system.

General concepts about chemical root control results:

- It can be very difficult to determine if a root mass is dead with a visual inspection via TV camera.
- The effectiveness of chemical root control is only as good as the application.
- Do not expect a treated pipe to have a clean "gun barrel" look following a chemical treatment.

The term root control as used in this manual refers to "root management". The entire concept of sewer line root control is to reduce the frequency and size of root intrusions into sewer pipes thus reducing the frequency of sewer stoppages and overflows.

Application Equipment

Equipment design and specific components of foam generating and application equipment may vary but the basic principals of operation are the same, namely:

- The chemical and wetting/foaming agent is diluted with water as per chemical manufacturer's label instructions.

One type of equipment utilizes a mix tank (30 to 300 gallon) in which the chemical ingredients are diluted with water. This mix tank is usually trailer mounted. The trailer is then used to transport the chemical to the various applications sites throughout the municipality. One 200 gallon tank mix is sufficient to treat approximately 1600 feet of 8" pipe. The chemical/water solution is delivered under pressure (100 - 150 psi) to a foam production chamber. A positive displacement pump is then used to pump the chemical/water solution.

A second type of equipment utilizes a small (3 to 6 gallon) chemical tank in which the chemical ingredients are mixed but water is not added. This unit utilizes a positive displacement roller pump or the pump on a hydrojetter unit to deliver water (without chemical) under pressure (100 - 150 psi) to a venturi at which point the chemical is introduced into the water stream and mixed just ahead of the foam production chamber. The chemical is then diluted with water during the application process. The chemical/water dilution ratio is based on the product's concentration of active ingredients (identified on the product label).

- Ten to fifteen CFM (80 - 140 psi) of air from a compressor is combined with the water/chemical solution in the foam production chamber to produce the desired foam.

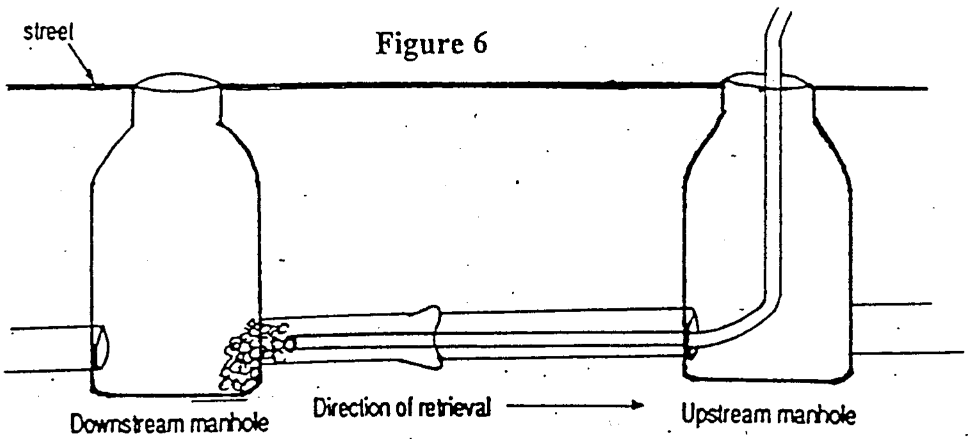
- Foam is delivered to the interior of the pipe being treated through hoses of varying sizes.

Foaming Techniques for Applying Metam-Sodium Root Control Chemicals

Hose Insertion Method

The hose insertion method is the most common and lowest risk method of foam application. A foam delivery hose is inserted through a section of pipe to be treated. Foam is then pumped from a foam generator through the hose as it is being retrieved at a predetermined rate. The foam delivery hose may require an external mechanism such as a hydrojetter or rodding machine to convey the hose through the pipe prior to the foaming process. This procedure utilizes a two stage nozzle and foam generation equipment adapted to a standard high pressure hydrojetter. During the first stage, the nozzle is "jetted" through the pipe to be treated. The second stage occurs when the pressure drops and the large portion of the nozzle opens to allow the foam to be pumped out. See Figure 6.

Figure 6



Although the insertion manhole may be upstream or downstream, it is best to use the upstream manhole for insertion as this avoids drift of the chemical towards the applicator. Once the hose reaches the other manhole, start the equipment and wait for foam to appear. Retrieve the discharge hose at the desired rate. With jetters, it is recommended that moderate pressure be used when inserting the hose into the pipe. High pressures and excessive cleaning may result in extensive root damage which can affect the effectiveness of the root control application.

Hose Insertion Method, Split Treatments

In some cases, the sewer stretch may be longer than the amount of discharge hose or it may not be possible to get the discharge hose completely through the sewer. In this case, it may be necessary to use two set-ups to treat a section. With this technique, it is best to treat the downstream portion first to reduce possible exposure of the applicator to chemical drift.

Hose Insertion Method: "Pushing a Slug"

Foam will penetrate a distance beyond the discharge nozzle. This is known as "pushing a slug". If masses of roots or physical obstructions do not permit the hose to be conveyed completely through the sewer, the equipment may be "allowed to pump" at a fixed location until the foam works its way through the obstruction. The equipment is then set up at the opposite manhole and the procedure is repeated until the two "slugs" overlap.

EXTREME CAUTION: Extreme caution should be employed when using this method as foam may travel farther than desired up service laterals. Foam will always take the path of least resistance; this may be up a cellar floor drain or through outside building clean-outs.

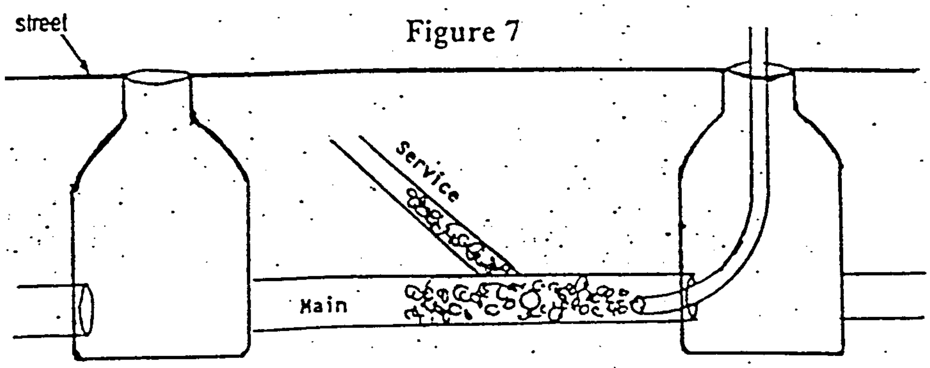
Hose Insertion Method: "Pulling the Water Out"

In some cases sewer pipe may have inadequate slope or swales in which water collects. As the foam is injected it displaces the water in the pipe. Under these conditions it is often advisable to treat using the downstream manhole as the insertion manhole. As the hose is retrieved, excess water is pulled toward the insertion manhole. If the upstream manhole is used as the insertion manhole, then water may pond in the upstream manhole. If this happens, equipment must be shut down until water recedes.

Hose Insertion Method: Treating "Wye" Connections from the Main

Often it is desirable to treat service connections from the main. This provides an important side benefit to homeowners. Generally, treating service connections from the main is only feasible in small diameter (6" through 10") pipe. In large diameter pipe, it is not possible to build up the pressures needed to penetrate service connections. See Figure 7.

Figure 7



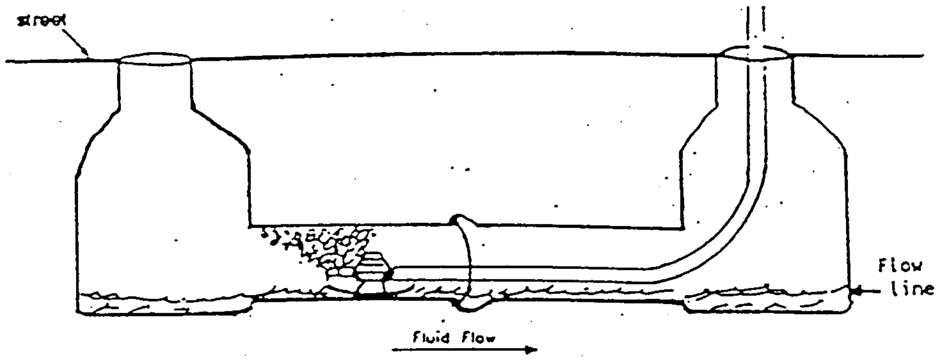
Foam takes path of least resistance

Additional foam is required per foot to use this method. Calculate the amount of additional foam required for the given number and pipe size of building laterals and vary retrieval rates accordingly. **USE EXTREME CAUTION** to prevent foam from reaching building drains or outside sewer cleanouts.

Surface Coating Large Diameter Pipe

When treating large diameter pipe, it is often impossible, or too costly, to completely fill the sewer with foam. Only that chemical which contacts roots is useful. Excess chemical that drifts downstream is wasted and could affect the wastewater treatment plant. To coat the pipe surface, an elevated nozzle (Figure 8) is pulled through the sewer. Foam is ejected through the nozzle above the flow where it contacts and sticks to pipe surfaces. It is very important that the nozzle be elevated above the flow. If the foam is ejected into the flow it will not contact pipe surfaces. To calculate the volume of foam required to coat the surface, contact your chemical supplier for instructions.

Figure 8



Surface coating often does not yield the results obtained by filling the pipe, since the foam is not under pressure and will not penetrate root masses as effectively as it would when filling the pipe. Repeat treatments may be necessary as succeeding "layers" of root tissue are killed off. Also, surface coating will not result in foam penetrating service connections. Surface coating is also used on small diameter pipe with heavy flow where the flow rates preclude filling the pipe with foam.

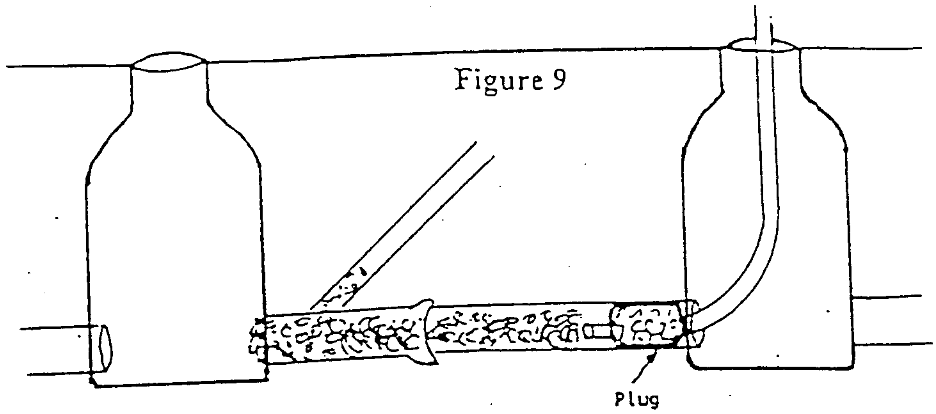
Spot Treatments

Spot treatments may be used with either foam filling or surface coating techniques. Spot treatments involve treating only where the roots are. The advantage of spot treatments is that less material is required to treat a given length of sewer pipe. The disadvantage is that television inspection is necessary to know exactly where the roots are located. If the TV inspection is outdated, additional root penetration may have occurred. Additionally, initial root penetrations are frequently missed by TV inspection. Spot treatments are most useful in large diameter lines where the increased cost of material offsets the cost of TV inspection. The amount of chemical which can be saved on small diameter pipe is usually negligible and not worth the cost of TV inspection.

When using spot treatment techniques, allow a certain amount of overlap, approximately 10 feet, on each side of the root masses.

"Pushing" Foam Through Inflatable Plugs

In some cases, it may be desirable to "push" the foam through inflatable, hose-through plugs (figure 9). These plugs are available through plug vendors in the sewer industry. Insert the plug at one end of the line with the hose running through it. Inflate the plug and inject foam in a volume required to fill the pipe or until foam appears at the opposite manhole.



CAUTION: **This is a high risk method.** When using this method there is a **significant hazard of foam backing into buildings** because foam will always follows the path of least resistance. This method should only be used where there are no service connections on the main-line sewer or where buildings are set far back from the main.

Treating Building Sewers

Treating house lines also involves the use of hose-through inflatable plugs. Some equipment manufacturers have developed specialized, portable equipment for treating building sewers.

Insert the hose-through plug in a cleanout which is **downstream from all other cleanouts and fixtures.** If there are cleanouts or fixtures downstream from the insertion cleanout, they must be plugged. Calculate the volume of foam necessary to treat the given distance of building sewer. Turn on the equipment until the desired quantity of foam has been pumped.

Treating house lines should only be attempted by applicators familiar with the design of building sewer systems or under the supervision of a licensed plumber. **Improper application may result in foam being discharged into houses.** If a rotten egg or sulfur-like odor of metam-sodium is detected, **building occupants should be advised to exit a structure until the building is ventilated.**

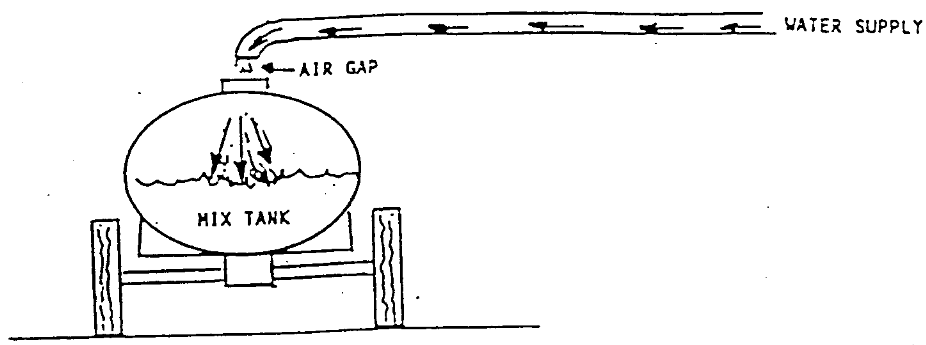
Filling Chemical Mix Tanks

When using chemical mix tanks certain precautions must be followed. Applicators often fill mix tanks from fire hydrants, garden hoses, or other fresh water sources. If there is a pressure drop in the water distribution system the solution in the mix tank could back-siphon into the fresh water system, contaminating the entire fresh water distribution system. Also, this could happen when drawing water from any other source, such as a farm pond. Whenever a tank is being filled with water, it should never be left unattended. Back-siphoning can be prevented with one of the following measures:

- use of an air-gap,
- use of a back flow prevention device such as a double check valve, or
- use of an intermediate water source, such as a jetter.

An air gap is shown in Figure 10.

Figure 10



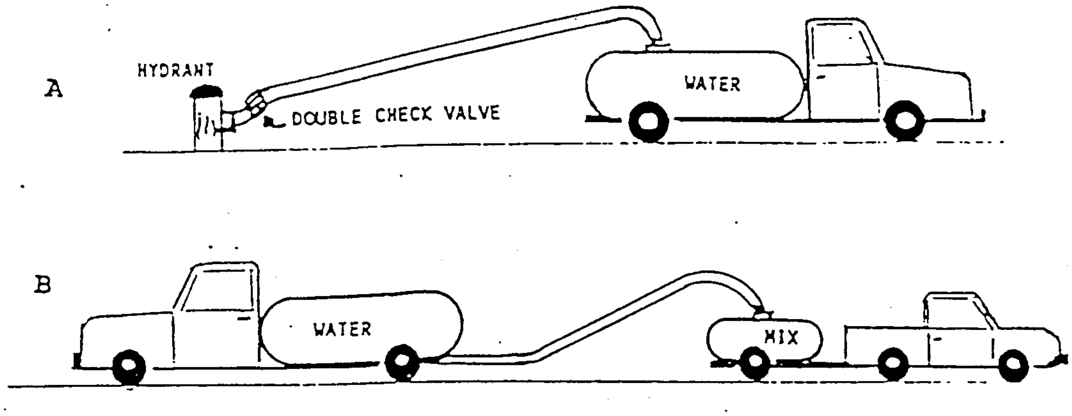
For an air-gap to be effective, the distance between the inlet line and the tank (d) must be at least twice the diameter of the inlet line (D). In the event of a reversal of pressure, air will rush through the air-gap, preventing siphoning. It is difficult to use an air gap with foaming root control chemicals as the residual material in the tank will foam and prevent the tank from being filled.

Back flow preventer
This is a device that is connected between the water source and filling hose. If the pressure on the outlet side of a reduced pressure zone (RPZ) ever exceeds the pressure on the inlet side, relief valves discharge onto the ground, preventing back-siphoning. (For a more complete technical description of how a RPZ device works, consult a manufacturer.)

Double check valves are mechanical devices that prevent backflow.

Filling from an intermediate source. It is often useful to fill mix tanks from an intermediate source, such as a sewer jetter. In these cases, of course, the sewer jetter must itself be filled using an air-gap or double check valve. The advantage is that in the event of back-siphoning from the mix tank into the intermediary source there is no danger of contaminating fresh water supplies. See Figure 11.

Figure 11



Obtaining water from a jet truck will also prevent back siphoning because the truck has built-in siphoning brakes.

When mixing metam-sodium with water, remember that metam-sodium decomposes to the more volatile and toxic MITC. This process starts immediately and proceeds rather rapidly. Therefore, plan to use the solution soon after mixing, otherwise the material will be ineffective.

Cleanup of Pesticide Spills

Minor Spills

Control the spill. Prevent further spill. Keep people away from spilled chemicals. Rope off the area and flag it to warn people. Do not leave unless someone is there to confine the spill and warn of the danger. If the pesticide was spilled on anyone, follow appropriate cleanup procedures.

Confine the spill. Prevent the spill from spreading by building a dike of soil or sand around the spill.

Clean up the spill. Use absorbent material such as soil, kitty litter, sawdust, or an absorbent clay to soak up the spill. Shovel all contaminated material into a leak proof container or chemical resistant bag for disposal. The disposal container must bear a label indicating contents. Dispose of material as you would excess pesticides. Do not hose down the area as this spreads the chemical. Always work carefully and do not hurry. Do not let anyone enter the area until the spill is completely cleaned up.

Special Procedures for Foam Spills
Foam spills act very similar to liquid and if left unattended they break down to the liquid form. Although the clean up procedures are very similar, extra measures may be required.

Outdoors. Try to pick up the foam as quickly as possible before it liquefies. Scoop foam up with a shovel and transfer it to a manhole or place it in large, chemical resistant plastic bags. Empty the foam into a manhole. Triple rinse the bags before disposing of them in a landfill. For spills on the pavement, dispose of the foam in a manhole and then rinse the area into the manhole. If the spill occurs on soil, remove all contaminated soil and place it in sealed containers and dispose of it in accordance with local regulations.

Indoors. Spills will usually occur in bathrooms, basements or laundry rooms. Evacuate the building if the pungent, rotten egg or sulfur-like odor of metam-sodium is detected. Open exterior doors and windows and ventilate with fans. Seal all heating and air conditioning vents to prevent contaminating the system. Scoop up foam with a shovel or dust pan and place it in a plastic bag. Seal the plastic bag and remove if from the building. Dispose of foam in the nearest manhole. Triple rinse the plastic bags and dispose of them in a landfill. On hard floors, wipe up remaining liquid with rags or other absorbent material and dispose of as directed by local regulations. Wash the floor at least three times with detergent, flushing each down a drain. On rugs and cloth, take them outside, if possible, and dry them before laundering separately. On carpeting use a wet vacuum and flush foam down the drain. Shampoo with detergent at least three times. Ventilate area and allow to dry. If odor persists, remove and replace the material.

Major Spills
The cleanup of a major spill may be too difficult for the sewer applicator to handle or the applicator may not be certain what to do. In either case, keep people away, give first aid if needed, and confine the spill. Contact the Washington Department of Emergency Management by calling (800) 262-5990. Another available resource for emergency information on spills, leaks, or fires is the Chemical Transportation Emergency Center (CHEMTREC) in Washington D.C. CHEMTREC can be reached at (800) 424-9300. **For further information on pesticide spills, refer to WSU's manual, *Washington Pesticide Laws and Safety* (MISC0056).**

Calculating Amount of Chemical Required

The applicator can use the worksheets in Figures 12 and 13 to calculate the amount of chemical required for a specific job. Figure 12 is the calculation for the *foam fill* method. In larger pipe the foam/chemical is directed toward the pipe walls rather than filling the whole pipe. The *foam spray* method (figure 13) requires less chemical thus protecting the system from injecting too much chemical at one time. When using these figures, the applicator needs to add to the formula: 1) the number of feet of each pipe size that will be treated and, 2) the dilution ratio.

To determine the dilution ratios, the applicator should refer to the label of the product being used. For example, if the product label states "mix 25 parts water to 1 part of chemical" then insert "26" (26 parts

FOAM FILL APPLICATION

Pipe Size	Gallons per/foot	Length of Pipe	Gallons of Foam	Service Laterals 15 - 25%	Total Foam Required	Expansion Ratio 1:20 Required	Chem/Water Solution	Dilution Ratio Required	Total CMG	Round Up
4"	0.7	x	=	+	=	÷ 20	+	÷	=	
6"	1.5	x	=	+	=	÷ 20	+	÷	=	
8"	2.5	x	=	+	=	÷ 20	+	÷	=	
10"	4.0	x	=	+	=	÷ 20	+	÷	=	
12"	6.0	x	=	+	=	÷ 20	+	÷	=	

Figure 12

FOAM SPRAY APPLICATION

Pipe Size	Gallons per/foot	Length of Pipe	Gallons of Foam	Service Laterals 15 - 25%	Total Foam Required	Expansion Ratio 1:15 Required	Chem/Water Solution	Dilution Ratio Required	Total CMG	Round Up
12-14"	3.0	x	=	+	=	÷ 15	+	÷	=	
15-16"	3.5	x	=	+	=	÷ 15	+	÷	=	
18"	4.3	x	=	+	=	÷ 15	+	÷	=	
20"	4.5	x	=	+	=	÷ 15	+	÷	=	
21"	4.75	x	=	+	=	÷ 15	+	÷	=	
22"	5.0	x	=	+	=	÷ 15	+	÷	=	
24"	5.5	x	=	+	=	÷ 15	+	÷	=	
26"	6.0	x	=	+	=	÷ 15	+	÷	=	
27"	6.75	x	=	+	=	÷ 15	+	÷	=	

Figure 13

of chemical/water solution) in the "dilution ratio required" column of either figure 12 or 13 and complete the calculation.

Application Checklist

This check list should be reviewed before applying root control chemicals containing metam-sodium to a sewer section. **ALWAYS READ THE PRODUCT LABEL COMPLETELY PRIOR TO APPLICATION.**

1. Read the chemical product label thoroughly.
2. Notify the wastewater treatment plant operator and workers of treatment site and date.
3. Know the distances between buildings and the sewer.
4. Know the depth of the sewer compared to the drains in the buildings.
5. Are there any obstructions in the line?
6. Are there broken or empty traps?
7. Are there drains without traps that would allow easy emergence of foam? (Building drains may be plugged to protect against back-up and flooding.)
8. Product labels and Material Safety Data Sheets should be available at job site for quick reference.
9. Provide job site with all necessary equipment for proper traffic control (i.e., barricades, cones).
10. Provide the job site with proper equipment for safely opening manholes.
11. Provide the job site with proper equipment for conforming with OSHA standards, for confined space entry (including but not limited to air monitor, harness, and retrieval systems).
12. Have the proper PPE available:
    - gauntlet type chemical resistant gloves,
    - rubber boots,
    - chemical resistant, full length plastic or rubber apron,
    - respirator and goggles or a full face respirator with cartridges approved for pesticide use, and if required air supplied respirator or SCBA,
    - long pants and long sleeved shirts, and
    - hard hat
13. Have spill clean-up materials available.

Communication with the wastewater treatment plant personnel.
Coordination and cooperation with plant operations is very important. Notification prior to treatment is a definite priority, especially with the pre-treatment program which may require issuance of a discharge permit. Treatment plant personnel should be made aware of any unusual side effects of metam-sodium.

The applicator should obtain as much information about the treatment area as possible. For example, the times of high flows, the size of the sewer lines being chemically treated and the distance of the sewer line from the nearest lift station and sewage treatment plant. These are important determinants of the effects of chemical root control on a wastewater treatment plant's processes. Sewer line size is an important consideration because of the amount of material required to chemically treat them. Depending on the application method used, it can take up to 9 times as much chemical per foot to treat a 24" sewer as an 8" sewer.

Dosage of Product to a Particular System

In order to minimize the effects of root control chemicals on a sewer system, it may be necessary for the applicator to reduce the volume of material applied. Knowing the volume and hourly flows for the system and the manufacturer's recommended maximum concentrations, the applicator can determine the maximum amount of product that can be injected into the system for any given day or hour.

If adverse effects are indicated at the treatment plant (i.e., the rotten-egg odor of metam-sodium is detected or the beginning of biological upset is determined) the application process should be immediately discontinued. When applications are re-started, the applicator should use reduced application rates, namely fewer total gallons of concentrate per hour or day. The treatment plant operators should continue to monitor the plant to ensure against a reoccurrence of the adverse effects.

Metam-Sodium Root Control Application

The three phases of applying the metam-sodium root control chemicals are 1) mixing the chemicals or the chemical/water solution, 2) calibrating a 1 part chemical/water solution to 20 parts foam, and 3) calibrating the hose retrieval rate.

Mixing the Chemical

Due to the differences in packaged products, specific mixing instructions must be obtained from the label of the metam-sodium root control products being applied. Mixing instructions must also be obtained from the equipment manufacturer for the specific application equipment being used.

The active ingredients, metam-sodium and dichlobenil, can only be used in combination with each other and with a foaming agent as per the product label. Depending on the equipment being used, the ingredients may be mixed with the proper amount of water in a mixing tank or may be mixed only with themselves in a small chemical tank to be automatically mixed with water at the moment of application.

Dichlobenil should be mixed with the other root control ingredients vigorously before mixing with water. The mixed solution should not be allowed to stand as mild agitation is necessary to keep the dichlobenil in suspension.

The chemical mixture should be used promptly after mixing and the applicator should not mix more solution than can be used in one day. To mix the proper amount of needed solution, the applicator must: 1) determine the method of treatment, 2) determine the total footage of pipe by using the pipe diameter and method of treatment, and 3) calculate the chemical mix ratio and the amount of chemical/water solution to prepare depending on the pipe diameter and method of application.

Methods of treatment include the foam fill and foam spray. Pipe diameters 12" - 14" or less require filling the entire pipe void with foam (Foam Fill). Pipe diameters 12" - 14" or larger are more economically treated by surface coating on the root masses and pipe surface (Foam Spray). Other factors may dictate the method of application e.g., wastewater level, velocity of flow and root density.

Calibrating Foam/Solution Expansion Ratio

The applicator should know how to calibrate the application equipment to get the proper consistency and volume. This section provides general guidelines for equipment and foam calibration. Consult with the equipment manufacturer for more specific calibration details of their equipment.

Metam-sodium root control products require a foam application. The ingredients are mixed with water, according to the package instructions, and then air is introduced with an air compressor. The proper chemical/water to foam expansion ratio is an important factor in achieving a successful root control application. The proper expansion ratio is that 1-part, or 1-gallon, chemical/water solution will expand to 20 parts, or gallons, of chemical/foam solution.

The proper foam will be dense, have small bubbles, "cling" to the pipe surfaces, maintain its shape for a specified period of time, and contain the proper concentration of active ingredient per cubic foot of foam.

An expansion ratio less than 1:20 produces a "wetter" foam. A wet foam will be "runny" and not stick to pipe surfaces. It will also be "heavy" and quickly collapse, not holding its shape in the pipe. Additionally, wet foams will not properly fill pipes at normal retrieval rates or penetrate wye connections.

An expansion ratio greater than 1:20 produces a "dryer" foam with large bubbles that will not carry a sufficient concentration of active ingredient per cubic foot to be effective at killing tree roots.

Variations in foam quality can be made by adjusting the water/chemical solution volume (gallons per minute(gpm)) versus the air volume (cubic feet/minute (CFM)). Follow the equipment manufacturers guidelines to make these adjustments.

The water quality (i.e., hardness) may effect foam quality. If this is a problem, check with the chemical manufacturer or supplier for technical assistance.

The applicator can test the foam quality by observing it as it discharges from the hose into a manhole. A good foam consistency is achieved when the stream breaks into light balls and flakes of foam about 2 - 3 feet from the point of discharge.

These tests for foam quality or equipment calibrations can be performed at a testing site by using the appropriate amount of wetting/foaming agent only (without adding the product's active ingredients). This reduces the risk of exposure for the operators performing the test. The wetting/foaming agents can readily be obtained from the product manufacturer. Contact the equipment manufacturer for detailed calibration procedures specific to their respective equipment.

To measure the foam more accurately from the mound of foam created, fill a 2000 ml graduated cylinder to the top. Once filled place the cylinder in a location free of wind (wind causes unnecessary breakdown of the foam). When the foam has settled, measure the remaining liquid. The desired result is to have the liquid measure 100 ml or 1/20th of the foam volume.

Each piece of equipment should be calibrated separately to determine its proper flow rate. If a piece of equipment shows wide variances in foam consistency, there may be a problem with the equipment. Service the equipment per the equipment manufacturer's recommendations.

Calibrating the Hose Retrieval Rate

To determine the hose retrieval rate, the operator must know:

1) the gallons of foam required per foot of sewer pipe, and
2) the amount of gallons per minute that the application equipment is producing.

Divide the amount of foam produced per minute by the amount of foam required per foot to determine the hose retrieval rate in feet per minute.

Figure 14 provides a quick method of determining retrieval rates.

Figure 14

Pipe Size	Foam Fill gal/ft	Feet per minute
4"	0.7	143
6"	1.5	67
8"	2.5	40
10"	4.0	25
12"	6.0	17

This same procedure can be used for determining the hose retrieval rate for surface coating applications. For example: to surface coat a 24" pipe carrying 7" of flow, with 3" of foam for 300 feet in length it requires 2,221 gallons of foam. This breaks down to 7.4 gallons of foam per foot. If the equipment is generating 90 gallons of foam per minute then the proper hose retrieval rate would be 12.16 feet per minute (90 ÷ 7.4).

Determining Effectiveness of Root Control Treatments

Determining the effectiveness of chemical root control treatments is an important issue for contractors and public works officials. The results of chemical root control are sometimes difficult to assess because they cannot be seen by the naked eye. Tracking results can also be a learning tool for the applicator by pointing out deficiencies in application methods.

Conditions which may influence effectiveness include:

- Improper application techniques, in particular, poor contact and exposure time,
- High sewer flows or surcharging conditions soon after application,
- Severe hydraulic sewer cleaning before or after treatment,
- Heavy grease deposits on roots which interfere with chemical contact, and
- Old, ineffective or improperly mixed chemical.

Due to the remoteness of root masses in sewer pipes, it is extremely difficult to accurately assess the percentage of the root kill. An important fact to remember is that chemical root treatments kill the roots but do not make the roots disappear. A complex of decaying organisms, constantly present in the sewer, feed on the dead roots. In addition, the build-up of solids and the ever constant pressure caused by wastewater flows breaks the dead roots off, sending them to the treatment plant. This process may take weeks, months, or even years.

NOTE: If a sewer line is experiencing frequent blockage problems, chemically treating roots will not immediately eliminate these blockages. You need to address these blockages with a good cleaning, preferably with a high pressure jetter. Once the blockage problem is resolved, the long term solution of chemically treating roots can be addressed.

As discussed previously in the section on how roots grow, root masses are made up of a central trunk dividing into a series of smaller and smaller branches and ending as microscopic hair roots. A specific root mass in a pipe may be the result of single rootlets entering the pipe through a faulty pipe joint. These rootlets then grow and divide into more rootlets which in turn divide and grow forming a "root mass". As the root mass grows, the supporting branch (the original root hair entering the pipe) grows in size and is frequently protected by the surrounding root mass.

The most difficult part of a successful chemical root treatment is accurately determining the percent kill of a root mass or root masses in a specific section of pipe. When viewing the root masses insitu (in place in the pipe) with the use of closed circuit TV, a live root mass looks brown and dirty and, due to equipment lighting, the root masses tend to reflect light causing glare and "hot spots". The same closed circuit TV of a dead root mass also looks brown and dirty with glare and hot spots. The insitu inspection becomes a case of judgment on the part of the inspector. With time, the root mass becomes smaller due to decay and breakage. The contents of a dead root mass becomes soft or brittle and break off easily as the camera passes. These factors all become part of the assessment of the success of a specific chemical root control treatment. The confidence level of these judgment calls can be significantly increased by removing a root mass from the pipe for a detailed visual inspection.

Like the trees above ground, roots grow in diameter by adding cells between the dead tissue in the root center and the dead bark (skin) on the outside. These healthy living cells create a light colored almost white layer under the bark. When a root is killed, this layer turns brown. By stripping the bark layer off the individual roots in a root mass, the effectiveness of a specific chemical treatment can be determined. When performing this visual test you need to remember that you are examining only one of perhaps hundreds of root masses from the specific section(s) of treated line. Due to nonstandardized conditions in a sewer system, what you find in one root mass may not be what you find in the next.

Perhaps the most reliable method of judging the success of a chemical root control program is to determine the rate of reduction in sewer stoppages, overflows, emergency calls, and other root-related sewer problems. For example, a municipality that experiences 100 stoppages per year in the year prior to implementation of a chemical program and 2 stoppages per year the year following implementation of the program, the program has shown positive results. The program could be justified by weighing the cost of the root control program against the cost of relieving stoppages and the damage caused by stoppages.

Although the ultimate goal of a root control program is to totally eliminate all root masses, in reality a successful program is one in which the roots are managed at a level where the cost and risk of application is less than the cost and risk of unwanted sewer blockages and damaged pipe.

Test Your Knowledge

Q. Briefly describe two types of foaming equipment.
A. 1) utilizes a 30 - 300 gallon mix tank in which chemical and water are mixed. The solution is delivered under pressure to a foam production chamber then pumped out as a chemical foam.
2) utilizes a small (3-6 gallon) tank into which only chemical is mixed. The chemical is pumped under pressure to a venturi where it is introduced into the water stream and into a foam chamber. Foam is then pumped out as in 1) above.

Q. Name the foaming techniques used for applying metam-sodium root control chemicals.
A. Hose insertion method, split hose insertion method, hose insertion - "pushing a slug", hose insertion - "pulling the water out", hose insertion - "treating wye connections", surface coating large diameter pipe, spot treatments, and pushing foam through inflatable plugs.

Q. When filling a mix tank, how can you prevent back-siphoning?
A. By using an air gap between hose and tank; by using a back flow preventer or double check valve; or, by using an intermediate water source, such as a jetter.

Q. What are the major steps for handling a pesticide spill?
A. Control the spill to prevent spilling more pesticide. Confine the spill to keep it from spreading. Clean up the spill by placing it in labeled containers and disposing of the material in an approved manner.

Q. How can an applicator calculate the amount of chemical required for a specific job?

A. Determine if the foam fill or foam spray method will be used. Select the appropriate chart for that method. Then refer to the product's label to determine the amount of water to mix with 1 part of chemical. This total will be used in the "dilution ration required " column to complete the calculation.

Q. Why is it necessary for the certified applicator to communicate with treatment plant personnel?

A. (1) to alert personnel that a chemical will be introduced into their system so they may monitor for signs of upset and any unusual side effects from the chemical;

(2) it may be necessary for the pretreatment program to obtain a discharge permit;

(3) so that the applicator can obtain information about times of high flow, sizes of pipe to be treated, and distances between different sewer structures such as lift stations and treatment plant.

Q. How do you calculate the hose retrieval rate?

A. Determine the gallons of foam required per foot of sewer pipe. Next, determine the gallons per minute that the application equipment produces. Then divide the amount of foam produced per minute by the foam required per foot to determine the hose retrieval rate in feet per minute. A chart is also available to assist the applicator.

Q. How can the applicator determine the effectiveness of root control treatments.

A. This is not easy. A combination of television inspection, pulling treated root masses and inspecting them for live tissue and comparing the rate of sewer stoppages before and after treatment works the best.

GLOSSARY

Activated Charcoal: Finely ground or granulated charcoal which adsorbs chemicals.

Active Ingredient: The chemical or chemicals in a product responsible for pesticidal activity.

Acute Oral Toxicity: Injury produced from a single exposure.

Acute Toxicity: The short-term, single exposure effects of pesticide.

Adherence: The ability of a pesticide or substance to stick to a surface.

Adjuvant: A substance added to a pesticide to improve its effectiveness or safety. Same as additive. Examples: penetrants, spreader-stickers and wetting agents.

Adsorption: The process where chemicals are held or bound to a surface by physical or chemical attraction. Clay, charcoal, and high organic soils adsorb pesticides.

Agitation: Process of stirring a pesticide solution so as to keep wettable powders, etc. in suspension.

Anti-Siphoning Device: A mechanism used to prevent the flow of a pesticide solution from a mix tank to a water source.

Back-Flow Preventer: see "Anti-Siphoning Device."

Bactericide: A pesticide that destroys or prevents the growth of bacteria.

Basal Application: Application of a pesticide to plant stems or tree trunks just above the ground line.

Building Sewer: That portion of a sewer system which lies between the building foundation and the collector sewer. Also called lateral sewer.

Bypass Pumping: The process of temporary re-routing sewer flows around a given section of sewer.

Calibration: The process of adjusting application equipment so that pesticides are applied at the proper rate. Also, the process of determining the rate at which a given piece of application equipment discharges pesticides.

Carrier: An inert ingredient used to dilute a mixture of pesticides, or to transport a pesticide to target.

Chemical Name: The scientific name for a chemical substance. Example: Sodium Methyldithiocarbamate is the chemical name for metam.

CHEMTREC: The Chemical Transportation Emergency Center. This organization operates a 24-hour information hot-line for pesticide spills, fires, and accidents. 1-800-424-9300.

Chronic Toxicity: The long-term effects of exposure to a pesticide.

Collector Sewer: A sewer, typically small diameter, which collects wastewater flows from buildings and transports those flows to an interceptor sewer.

Combined Sewer: A sewer which is designed to carry both sanitary flows and storm water, either all or part of the time.

Combined Sewer Overflow: see Overflow.

Commercial Applicator: One who engages in the business of apply pesticides to the property of another. Washington State requires commercial applicators to be licensed through the Washington State Department of Agriculture.

Common Name: A generic name given to an active ingredient that is generally accepted in pesticide nomenclature. Distinguished from chemical name or brand name. Examples: Metam, Dichlobenil, Copper Sulfate.

Compatibility: The ability of two pesticides or substances to mix without reducing the effectiveness or usefulness of either substance.

Contact Herbicide: A chemical that kills primarily by contact with plant tissue, with little or no translocation.

Decomposition/Degradation: The process by which a chemical substance is broken down into simpler substances. This process can take place through chemical, biological, or physical means.

Deposit: The amount of pesticide left on a treated surface (noun). Also, the process of leaving a pesticide on a treated surface (verb).

Dermal Exposure: The absorption of a pesticide through the skin, eyes, or mucous membranes.

Dermal Toxicity: The ability of a pesticide to cause injury to a human or animal when absorbed through the skin.

Desiccant: A chemical that promotes drying or loss of moisture from plants and animals such as insects.

Detoxify: The ability of a substance or process to render a pesticide harmless.

Dust: A dry mixture containing pesticide(s) and inert ingredients.

Easement: In sewer work, the location of a sewer line in back-yards, parks, public lands, off-road, or other areas which are typically more difficult to access than sewers located beneath street surfaces. Also, the right of government to access manholes and sewer lines which are located on private property.

Effluent: Water which is leaving a structure. Example: the discharge from a water treatment plant.

Engineer: In sewer work, the designated official of a municipality who represents and is authorized to act on behalf of a municipality with respect to the municipality's dealings with a contractor.

Exfiltration: The leakage of water or other substances from a sewer pipe into the ground through joints, cracks, or defects.

EPA: The Environmental Protection Agency, the federal agency responsible for regulating and enforcing the registration, sale and use of pesticides.

EPA Registration Number: The number assigned to a pesticide by the EPA. This number must appear on all pesticide labels.

FIFRA: The Federal Insecticide, Fungicide, and Rodenticide Act. Most important legislation concerning pesticide usage.

Foaming Agent: An adjuvant used to convert a pesticide solution into a thick foam. Used in agriculture to prevent drift; in sewer line root control as a carrier and to prevent drift.

Foam Retardant: An adjuvant used to prevent foaming of a pesticide mixture.

Formulation: A mixture of pesticide(s) and inert ingredients. The pesticide product as purchased.

French Drain: A perforated or porous conduit used to remove groundwater from an area and convey it downstream.

Fumigants: Pesticides which form a vapor or gas, usually in a confined space or enclosed area, that are toxic when absorbed or inhaled.

Fungicide: A pesticide that kills or controls fungi.

General Use Pesticide: A pesticide which can be purchased and used by the general public. (see Restricted Use Pesticide).

Germicide: A pesticide that kills or controls pathogenic (disease carrying) bacteria.

GPM: Gallons per minute.

Groundwater: Water beneath the earth's surface that is the source of wells.

Grouting: The process of sealing pipe joints or other open sewer defects against groundwater infiltration.

Herbicide: A pesticide used to control or kill undesirable plants.

Incompatible: Two pesticides or substances that cannot be mixed together without adversely effecting their usefulness.

Inert Ingredients: A material that has no pesticidal effect, but which is contained in a pesticide formulation. See "adjuvant."

Infiltration: Ground water which enters sewer systems through joints or other defects.

Infiltration/Inflow Control (I/I): In general, the process of abating or controlling the introduction of extraneous water in a sewer system. Examples: grouting, re-lining, manhole rehabilitation, etc.

Inflow: Distinguished from infiltration, extraneous water other than groundwater that enters a sewer system. Examples: surface water which enters through manhole covers, water coming from roof leaders and foundation drains.

Inhalation: Exposure to a pesticide by breathing it in.

Influent: Water that is entering a structure. Example: sanitary sewer flows entering a wastewater treatment plant.

Inspector: A representative of the Owner or municipality who is actually on the job site supervising the quality of workmanship and materials.

Interceptor Sewer: Typically a large diameter sewer without service connections, which receives flows from collector sewers and transports the flows to a wastewater treatment plant.

Invert: The lowest point of a pipeline or conduit. The bottom part of a manhole that is rounded to conform to the shape of the sewer line.

Joints: The connection between two contiguous pieces of sewer pipe.

Lateral Sewer: Same as building sewer.

Leaching: The movement of a pesticide through soil by the movement of water.

Lineal Feet: A measurement of distance, in a straight line, between two contiguous manholes in a sewer system.

LD_{50}: The average lethal dose of a given pesticide for a given species. The amount that will theoretically kill 50% of a test group. Usually expressed in parts per million.

Manhole Section: Same as Sewer Section.

MGD: Millions of gallons per day. Used to express the design flow capacity, or actual flow, of a wastewater treatment facility.

Nematicide: A pesticide used to kill or control nematodes.

Nematode: Microscopic, colorless, worm-like animals that live as saprophytes or parasites. Many cause diseases or plants and animals.

Non-Systemic: A pesticide, usually a contact pesticide, which has a localized pesticidal effect only on the part of the plant or animal actually not transported through the plant or animal system in pesticidal concentrations.

Nonselective: A pesticide which kills or controls any living thing, or which is toxic to a wide range of organisms.

Oral toxicity: The occurrence of injury when a pesticide is taken by mouth.

Overflow: An undesirable discharge of sanitary or combined sewer flow into a river, stream, or other surface waters.

Owner: In sewer work, the municipality or public agency that maintains public sewers.

Parts per million (ppm): A typical measure of the concentration of a pesticide in another substance, or pesticide residues. One gallon of active ingredient in 1,000,000 gallons of water which represent 1 part per million.

Persistence: The ability of a pesticide to resist chemical or biological degradation, and therefore remains in the environment for an extended period of time. Persistent Herbicide.

Pesticide: Any chemical that will kill, repel, or otherwise control an unwanted plant, animal, fish, bird, insect, or microorganism.

Phytotoxic: The deleterious effect of a pesticide on the photosynthetic processes of a plant. Can be desired or undesired.

Receiving Waters: The body of water to which a wastewater treatment plant or storm sewer discharges.

Restricted Entry Interval: The period between the application of a pesticide and the time when people can reenter the treated area without having to wear PPE. protective equipment.

Residual Pesticide: A pesticide which remains active for an extended period of time.

Residues: The amount of pesticide which remains on the target or other surfaces following treatment.

Restricted Use Pesticide: A pesticide which can only purchased by a certified pesticide applicator and used only by certified applicators or persons directly under their supervision. Not available to the general public because of high toxicity and/or environmental hazards.

Rodenticide: A pesticide used to kill or control rats, mice or other rodents.

Run-off: The movement of pesticides on soil surface by means of water.

Sanitary Sewer: A sewer designed to carry only residential or commercial waste. As opposed to a storm sewer.

Selective Pesticide: A pesticide which is toxic to some species, but not to others.

Sewer Section: The length of sewer pipe connecting two manholes.

Soil Fumigant: A pesticide that forms a vapor or gas in soil, used to control pests in soil such as weed seeds, nematodes, bacteria, viruses, fungi, etc.

Soil Sterilant: Similar to soil fumigant, except that it kills all living organisms in soil usually for an extended period of time.

Solution: A mixture of one or more pesticides with another substance, usually water, in which all materials are dissolved or in suspension. The preparation of pesticides with water.

Spot Treatment: A local application of a pesticide to only a small area.

Storm Sewer: A sewer designed to carry only rain water, ground water or surface water.

Surcharge: The condition that exists when the volume of water exceeds the hydraulic capacity of a sewer.

Surfactant: A type of adjuvant which improves the spreading and/or wetting qualities of a pesticides.

Suspension: A pesticide mixture in which fine particles, usually a solid, float or mix evenly in water or oil.

Swale: A dip or sag in a sewer pipe, in which water and debris often collects.

Synergism: The action of two or more pesticides or substances which yields a result greater than that which any one of the substances is capable of achieving individually.

Systemic Pesticide: A chemical that is absorbed and translocated within a animal or plant. Some systemic pesticides are designed to protect the plant or animal against pests or else they are designed to cause injury to the organism.

Target: The organism to which pesticides are applied.

Translocation: The movement of a pesticide through vascular plant tissue.

Trade Name: A brand name of a pesticide. The same active ingredient may be sold under different trade names. Example: "Vapam" is a trade name for metam.

Volatility: The tendency for a substance to turn from a solid or a liquid to a gas.

Washington State Department of Agriculture (WSDA): Agency in Washington responsible for regulating the use of pesticides and certifying those individuals requiring a pesticide license.

Washington State University (WSU): Provides pesticide applicator training and materials in Washington State including study manuals for WSDA exams.

Water Table: The upper level of water saturated ground.

Weed: Any plant, that because it is in the wrong place at the wrong time, is deemed undesirable by man.

Wettable Powder: A pesticide formulation made by impregnating a powder with an active ingredient and wetting agent.